DOCUMENT RESUME

ED 338 108 FL 019 855

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TITLE	A Cognitive Academic Language Learning Approach: An ESL Content-Based Curriculum.
INSTITUTION	National Clearinghouse for Bilingual Education, Washington, DC.
SPONS AGENCY	Office of Bilingual Education and Minority Languages Affairs (ED), Washington, DC.
REPORT NO	ISBN-0-89763-118-8
PUB DATE	86
CONTRACT	300-85-0204
NOTE	100p.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Academic Achievement; Cognitive Style; Elementary Secondary Education; *English (Second Language); *Language Proficiency; *Learning Strategies; *Second Language Learning; Student Evaluation; Student Placement; *Transitional Programs
IDENTIFIERS	Cognitive Academic Language Learning Approach; *Content Area Teaching

ABSTRACT

The Cognitive Academic Language Learning Approach (CALLA) is an instructional program for limited English proficient (LEP) students who are being prepared to participate in mainstream content instruction. CALLA students are taught to use learning strategies derived from a cognitive model of learning as aids to comprehension and retention of concepts in the content area. This report provides a broad perspective on the integration of language, content, and strategy learning for LEP students at upper elementary and secondary levels. Intended to serve as a coordinating link between ESL or bilingual teachers and mainstream classroom teachers, the report contains five chapters on the following topics: characteristics of the CALLA model; English language development (1) through science, (2) through mathematics, and (3) through social studies; and assessment and evaluation (of academic achievement and English language proficiency). It is noted that the CALLA approach is based on the observation that many LEP students fail to realize the promise of their early successes in learning English by continuing to master English once they advance to content-area instruction. Contains 65 references. (LB)

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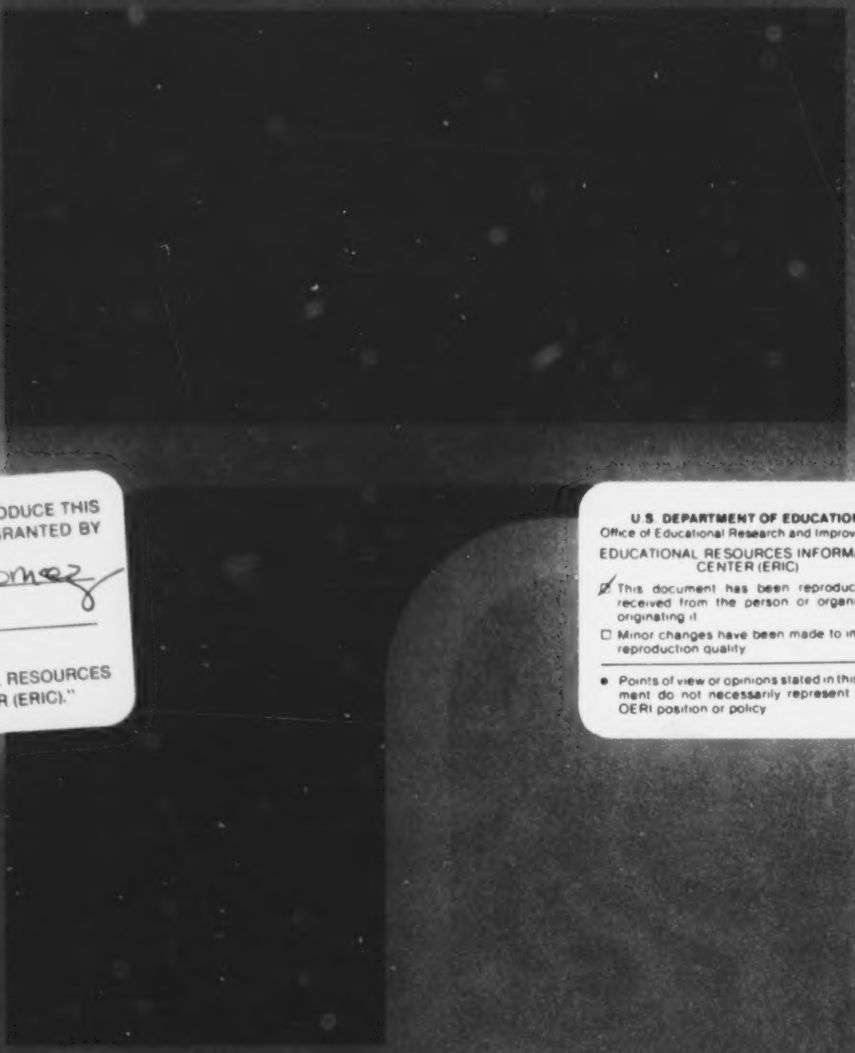
Anna Uhl Chamot and J. Michael O'Malley



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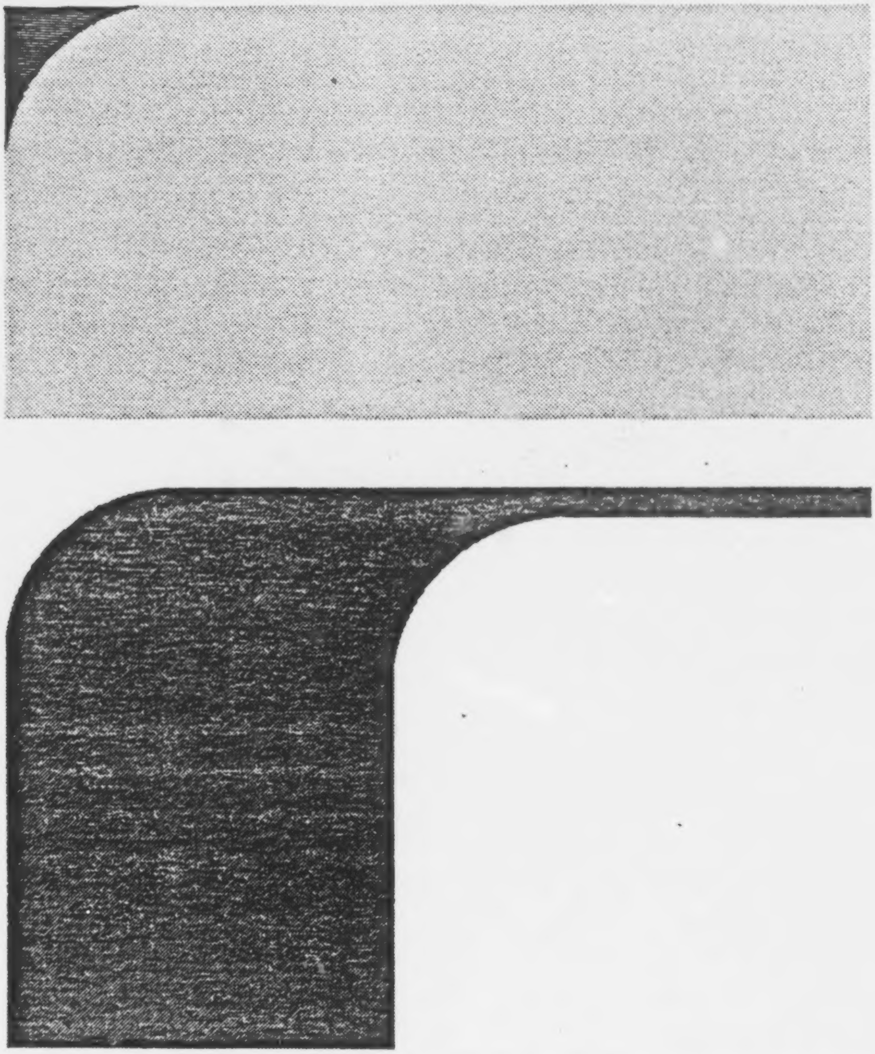

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ISBN: 0-89763-118-8
First Printing 1986
Printed in USA

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Foreword

The Cognitive Academic Language Learning Approach (CALLA) is an instructional program for limited-English-proficient (LEP) students who are being prepared to participate in mainstream content instruction. The program is designed to assist LEP students' success in school by providing transitional instruction between English as a second language (ESL) or bilingual education and mainstream instruction. The transitional instruction is designed to further academic language development in English through content area instruction in science, mathematics, and social studies. In CALLA, students are taught to use learning strategies derived from a cognitive model of learning as aids to comprehension and retention of concepts in the content areas. In brief, CALLA is designed to

- Meet the academic language needs in English of upper elementary- and secondary-level LEP students;

- Provide a program of content-based instruction that can serve as a bridge between the English as a second language or bilingual program and mainstream education;

- Provide instruction based on a cognitive model of learning.

In developing the CALLA model, we have drawn on our individual backgrounds and areas of expertise in the fields of second language learning and teaching, learning strategy research, cognitive psychology, curriculum development, and minority language educational programs. CALLA is the result of an interdisciplinary effort to improve the education of LEP students in U.S. schools. We plan to continue developing, refining, adapting, and testing our model in the hope that CALLA can make a significant contribution to the present and future needs of our growing minority language school population.

We developed CALLA to respond to a need. Many LEP students are still unable to do grade-level work in content areas, even though their oral English has been judged proficient. This problem has been attributed to the fact that the academic curriculum requires increased language demands particularly as students move beyond the primary grade level. Various researchers have found that the development of academic language skills lags behind the development of social communicative language skills (Cummins 1984; Saville-Troike 1984).

We believe that CALLA can meet the educational needs of three types of LEP students:

- Students who have developed social/communicative skills through ESL or exposure to an English-speaking environment, but have not developed academic language skills appropriate to their grade level;

- Students exiting from bilingual programs who need assistance in transferring concepts and skills learned in their native language to English;

- Bilingual, English-dominant students who lack academic proficiency in their native language and English and need to develop academic English language skills.

In addition, CALLA can help prepare high school students to meet minimum competency goals by showing them ways to approach the academically demanding activities in which they will need to demonstrate competence for high school graduation.

Before entering the mainstream curriculum, LEP students need to advance to a sufficient level of English proficiency so that they can use English as a tool for learning subject matter. This need becomes particularly acute from the middle elementary grades onward because the cognitive demands of subjects such as social studies, science, and mathematics become much greater than they have been at the primary grade level. By the middle elementary grades, students are expected to have mastered basic skills in reading, writing, and computation. At this level and increasingly at higher grade levels, the curriculum requires the use of English as a medium of thought. Students need to be able to read to acquire new information, to write to express their understanding of new concepts, to use computation skills in mathematics to solve mathematics word problems, and to apply effective learning strategies to all areas of the curriculum. For the LEP student, these requirements of the upper elementary and secondary school entail additional language demands. Language proficiency, which may have previously focused on communicative competence, must now focus on academic competence.

CALLA is a program, a curriculum, and an instructional approach. The program is transitional, following ESL instruction and preceding the mainstream program, and prepares LEP students for success in the mainstream. It is not an immersion program, and it does not substitute for either the ESL or the mainstream program. CALLA is a content-based curriculum designed to prepare upper elementary and secondary LEP students for a transition to the mainstream subject areas of mathematics, science, and social studies. Instead of teaching language in isolation, CALLA uses English as a tool for learning other subject matter. The literacy skills needed to read for information and write expository reports are also developed. The CALLA instructional approach is a cognitive one that develops students' ability to use effective learning strategies for both language and content-area tasks. The importance of integrating language learning with content learning has been stated by Mohan (1986, 18) as follows:

> Regarding language as a medium of learning naturally leads to a cross-curriculum perspective. We have seen that reading specialists contrast learning to read with reading to learn. Writing specialists contrast learning to write with writing to learn. Similarly, language education specialists should distinguish between language learning and using language to learn. Helping students use language to learn requires us to look beyond the language domain to all subject areas and to look beyond language learning to education in general. Outside the isolated language classroom students learn language and content at the same time. Therefore we need a broad perspective which integrates language and content learning.

The purpose of this book is to provide this type of broad perspective on the integration of language, content, and strategy learning for LEP students at upper elementary and secondary levels. We believe that this book can be of help both to ESL teachers who would like to add a content-based curriculum and learning strategy instruction to their program, and to classroom teachers who need assistance in developing English language skills, content area concepts, and learning strategies for the LEP students in their classrooms.

We hope that this book can serve as a coordinating link between ESL or bilingual teachers and mainstream classroom teachers, as all teachers need to work together to assist LEP students in making the transition to the all-English curriculum.

Anna Uhl Chamot

J. Michael O'Malley

March 1986

Chapter 1

Characteristics of the CALLA Model

The objective of the Cognitive Academic Language Learning Approach (CALLA) is to develop the academic language skills that limited-English-proficient (LEP) students need in order to participate successfully in mainstream classes. CALLA combines English language development with content-based ESL and adds learner strategies that help students understand and remember important concepts. The approach is an integrated program of content-area instruction in science, mathematics, and social studies. By participating in the types of activities identified in the CALLA program, LEP students at the upper elementary and secondary levels should be better prepared for the academic demands of mainstream education.

While in ESL classes, LEP students do not usually develop the ability to use English as a medium of thought in specific content areas such as science, mathematics, and social studies. These students may perform acceptably while in their special language programs but subsequently encounter difficulty because the language demands of academic content areas are different from those they encountered in their special language programs. In the content areas, students must use English to reason and analyze as well as to comprehend oral and written text, and they must learn new vocabulary and concepts that may have been introduced only briefly in their earlier instruction. The increased language demands, irrespective of the difficulty of the subject matter, may be the principal reason why many LEP students are unable to succeed in school.

Typically, the first mainstream academic course LEP students enter is mathematics because it is considered the least language-dependent area. Yet, considerable proficiency is needed to understand mathematical concepts and to solve word problems. Various researchers have pointed out some of the difficulties of the language encountered in mathematics. It not only has a specialized vocabulary but also lacks the redundancies which often assist comprehension and which exist in social interaction and narrative texts (Cuevas 1984; Dawe 1984; Mestre 1984).

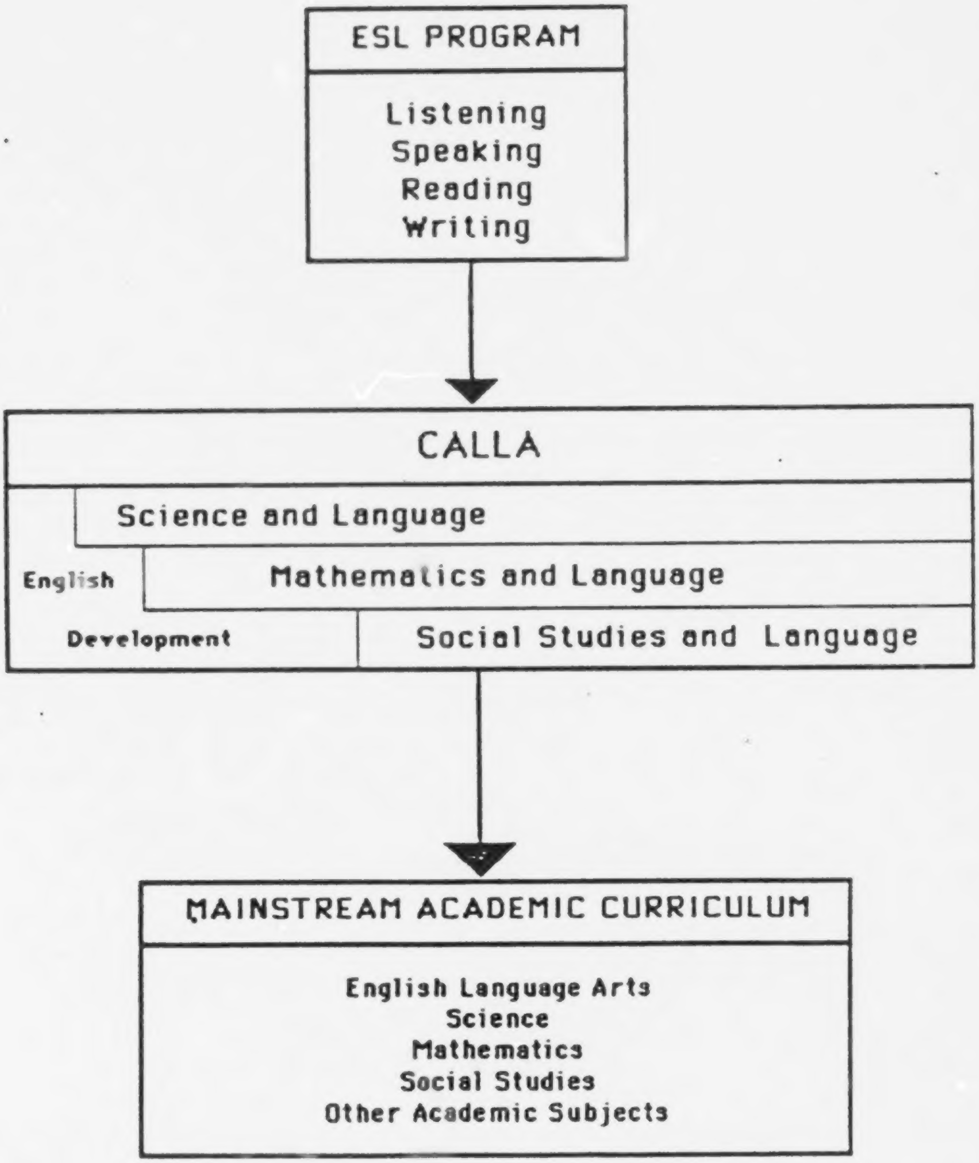
Science is generally the second course entered because the language of instruction is clarified through hands-on activities. However, as with mathematics, the language of science presents many difficulties for LEP students, particularly in higher grade levels. Understanding scientific concepts does not rely on demonstration and experimentation alone, but also on the ability to comprehend scientific texts (Chamot 1985a).

Social studies is often the third class into which LEP students are mainstreamed. Social studies curricula are heavily language dependent and require students to do extensive reading, discussing, and writing. As students move into the upper elementary and secondary levels, the social studies curriculum includes increasingly complex concepts in history, government, political geography, and environmental resources.

The CALLA program model suggests a different order for introducing content-based instruction to LEP students (see figure 1). This order is (1) science, (2) mathematics, (3) social studies. Science can be taught as

Figure 1

The CALLA Model: A Bridge to the Mainstream



experiential learning, capitalizing on hands-on activities, which makes it an ideal vehicle for language development. Science instruction uses objects or equipment to illustrate definitions, concepts, and principles. As students work on science projects in cooperative groups, the language needed to talk, read, and write about discovery experiences develops naturally.

Mathematics is suggested as the second area for content-based lessons because comprehension can be assisted by the use of concrete objects and numerical symbols as students learn to decipher the language of mathematical explanations and word problems. The CALLA model suggests social studies as the final area added to the transitional program. Social studies at the middle- and upper-grade levels requires extensive reading and writing, and these literacy skills need to be developed through ESL and in the experiential learning of science and mathematics before they can be successfully applied to social studies lessons.

Five sequential steps have been suggested for implementing a CALLA program (Chamot 1985b). These are:

- The instructional objectives of the program should be clearly defined and should be congruent with the objectives of the mainstream program;

- Inservice training should be offered for both ESL and content teachers so that they can cooperate to learn from each other and to develop a program that meets the needs of LEP students;

- The curriculum and course content need to be planned jointly by ESL and content-area teachers;

- Both groups of teachers should work together to develop and adapt the instructional materials to be used in the CALLA program; and

- Assessment procedures should be planned and instruments developed or adapted that are appropriate for LEP students.

The CALLA model has three components: (1) a content-based curriculum correlated to the mainstream program; (2) English language development in the academic areas of science, mathematics, and social studies; and (3) instruction in the use of learning strategies. Each of these components is discussed separately in the following sections, and the final section of this chapter provides guidelines for integrating these components into a single, unified instructional approach.

The Content-Based Curriculum

Content-based English language development is effective not only because it develops academic language skills, but also because it may be more interesting to students than ESL classes. Content areas such as science, mathematics, and social studies present numerous topics related to a variety of personal interests, whereas ESL classes focus on language only. LEP students are motivated by the topics presented and in knowing that they are developing the concepts and skills associated with these subjects. They are actually doing "real" schoolwork instead of merely learning English.

LEP students making the transition from a special language program such as bilingual education or ESL need systematic and extensive instruction and practice in the types of activities they will encounter in the mainstream class. An occasional, randomly selected ESL lesson on a topic in social studies or science will not adequately prepare students for the type of language-related activities in these subjects that they will encounter in the mainstream classroom. This is especially true in the middle and upper grades, where the curriculum in the content areas becomes progressively more demanding, both in terms of cognitive complexity and language demands. To be most effective, a content-based ESL curriculum should encompass the sequence and major scope areas of the mainstream curriculum. The topics incorporated should be authentic and important topics for the grade level of the students and should provide for the development of new knowledge and skills.

In a beginning-level ESL class, for example, middle- and upper- grade students learn to count and do simple arithmetic computation in English. But this is not an appropriate content-based English language development curriculum on the CALLA model for the older students because it is not sufficiently challenging. A curriculum that contains no new knowledge can rapidly become a series of exercises in translation of vocabulary and skills from the native language (L1) to English (L2), and may not stimulate students to begin to use the second language as a tool for learning. Instead, students who already have a background in a content area and who have already developed English proficiency through ESL instruction need a content-based curriculum in which they use English to solve problems and develop additional concepts that are appropriate for their grade and achievement levels.

For these reasons, it is important to base the curriculum used in the CALLA model on the mainstream curriculum at the appropriate grade level of the students participating in the program. Of course, adjustments will need to be made in the case of students whose previous schooling has been interrupted and who are therefore not at grade level in their native language. As with any instructional program, teachers should discover what students already know about a subject and then build on this previous knowledge by providing them with experiences that develop new concepts and expand previous ones.

English Language Development

In the CALLA model, reading and language arts are taught as part of content-area subjects. Teachers need to analyze the language demands of the different content subjects, which include the language of curriculum materials and of classroom participation, so that students can be taught the actual language functions, structures, and subject-specific vocabulary that they will need when they enter the mainstream classroom. These language demands are different from those of the beginning-level ESL class or the type of language used for social interaction, and need to be taught specifically and practiced in the context of actual subject-matter learning.

Cummins (1984) indicates that two dimensions can be used to describe the language demands encountered by LEP students. The first dimension concerns contextual cues that assist comprehension and the second concerns the complexity of the task. Language that is easiest to understand is contextualized and rich in nonverbal cues such as concrete objects, gestures, facial expressions, and visual aids. Language that is most difficult to understand is language in which context clues have been reduced to such a degree that comprehension depends entirely on the listener or reader's ability to extract meaning from a text without assistance from nonverbal cues. The second dimension describes the language demands LEP students encounter, the task difficulty, and suggests that comprehension is affected by the complexity of the cognitive demands in performing the task. Language tasks can range from the demanding to the undemanding. Examples of relatively undemanding language tasks are vocabulary, grammar drills, and following directions. More demanding tasks call on integrative skills such as reading and listening comprehension, and speaking or writing about academic topics. Tasks are especially demanding when reasoning skills are required.

Following Cummins' (1984) model, tasks involving language use can be classified into one of four categories: (1) cognitively undemanding and embedded in a context that clarifies meaning; (2) little context provided, but cognitively simple; (3) cognitively demanding, but context is provided; and (4) the language has both reduced context and cognitive complexity, making it particularly difficult for LEP students. Figure 2 describes typical language activities in each of the four areas. Allen (1985) has pointed out that ESL classes generally stress activities in category I, and that students are then mainstreamed directly into category IV activities. The sample activities listed in each area can provide the teacher with information about activities appropriate to the English proficiency level and age or grade placement of LEP students. The sample activities listed in category I might be used in beginning-level ESL classes. LEP students' first experiences with academic language could be planned around the activities listed in Category II. Some of these activities relate to personal or social communication, and others relate to school activities involving mainly rote learning. Academic content is included in the activities listed in category III, but context needs to be built into the activities to assist comprehension. Activities in this area require hands-on experiences and concrete referents. Finally, the activities listed in Category IV represent those of the mainstream classroom at the upper elementary and secondary levels. These are the kinds of activities that LEP students have most difficulty with because they are cognitively demanding and because the language associated with them is reduced in context.

The purpose of the English language development component of the CALLA model is to provide students with transitional language activities in Category II and III as well as practice with the context-reduced and cognitively demanding activities of Category IV.

Although some language activities may be integrated with mainstream content area instruction in the typical school curriculum, these may consist primarily of reading for information. LEP students need to develop not only content-area reading skills, but also the listening, speaking, and

Figure 2

Classification of Language and Content Activities*

	Nonacademic cognitively undemanding	Academic cognitively demanding
Context-Embedded	I Oral skills: Language drills with demonstrations and illustrations. Art, music, physical education, shop, some vocational subjects. Face-to-face conversation. Following simple, demonstrated directions. Playing a simple game.	III Listening skills: Demonstration of a process. Lesson with demonstrations and illustrations. Speaking skills: Making oral presentations. Answering higher level questions. Hands-on science activities. Math computation problems. Reading skills: Heavily illustrated text books. Math word problems with concrete referents or pictures All four language skills: Making models, charts, and maps in social studies.
Context-Reduced	II Oral skills: Uncontextualized language drills. Answering lower level questions. Predictable telephone conversations. Reading skills: Shopping list. Note from family member on predictable topic. Recipes. Directions on medicine. Oral reading. Writing skills: Copying words and sentences. Written pattern practice exercises. Reading and writing Skills: Writing answers to lower level questions. Filling out forms.	IV Listening skills: Content-subject explanation without demonstration or illustration. Reading skills: Reading comprehension. Math word problems without illustrations. Reading for information in content subjects. Writing skills: Compositions, essays. Reading and writing skills: Research and report writing. Writing answers to higher level questions. Standardized achievement tests.

*Adapted from Cummins' (1984) model.

writing skills associated with each subject. The number and variety of language activities in a content-based curriculum for LEP students should provide many opportunities for the development of academic language proficiency. The following aspects of language should be included in the language development component of the CALLA model of instruction for LEP students (Chamot 1985a):

- Development of the specialized vocabulary and technical terms of each content area;
- Practice with the language functions used in academic communication, such as explaining, informing, describing, classifying, and evaluating;
- Development of the ability to comprehend and use the language structures and discourse features found in different subject areas; and
- Practice in using the language skills needed in the content classroom, such as listening to explanations, reading for information, participating in academic discussions, and writing reports.

By integrating these types of language activities with grade-appropriate content, a curriculum based on the CALLA model can provide LEP students with the conceptual knowledge and language skills they will need to participate successfully in the mainstream classroom.

Learning Strategy Instruction

The CALLA model uses learning strategy instruction as an approach to teaching the content-based language development curriculum described in the preceding sections. Learning strategy instruction is a cognitive approach to teaching that helps students learn conscious processes and techniques that facilitate the acquisition and retention of new skills and concepts. The use of learning strategy instruction in second language learning is based on four main propositions.

1. Active learners are better learners. Students who organize and synthesize new information and actively relate it to existing knowledge should have more cognitive linkages to assist comprehension and recall than a student who approaches each new task by simple rote repetition.

2. Strategies can be learned. Students who are taught to use strategies and given positive experiences where they are applied will learn more effectively than students who have had no experience with learning strategies.

3. Learning strategies transfer to new tasks. Learning strategies will be used by students on new tasks that are similar to the learning activities on which they were initially trained.

4. Academic language learning is more effective with learning strategies. Academic language learning among students of English as a second language is governed by some of the same principles that govern reading

and problem solving among native English speakers, where extensive research has supported the effectiveness of learning strategy instruction (e.g., Chipman, Sigel and Glaser 1985; Weinstein and Mayer, in press).

While research evidence supports the first two propositions, the transfer of strategies to new learning tasks appears to require extensive instructional support. We have attempted to make learning strategies instruction a pervasive part of the CALLA program in response to this need, both to encourage use of strategies while the students are in CALLA, but also to encourage strategy use when the students exit to the mainstream curriculum. The fourth proposition is based in part on our own and others' observation that strategies for language and content learning are not distinct (O'Malley et al., 1985a; Wong Fillmore 1985) and in part on our positive experiences in training ESL students to use learning strategies on integrative language tasks (O'Malley et al. 1985b).

Instruction in learning strategies may be especially appropriate for upper elementary- and secondary-level students. Older children use learning strategies independently more often than younger children, and they can describe learning strategies they use and learn to apply new strategies.

A cognitive approach to teaching underlies much current thinking in mainstream education. In subjects as seemingly diverse as mathematics, science, and social studies, teachers are urged to develop students' concepts rather than have them only practice rote manipulation of facts. The process of inquiry is encouraged because it leads to the development of thinking skills. This current focus on teaching higher level processes has been accompanied by increased research on how learners process new information and what learning strategies they use to acquire concepts.

Learning strategies have been defined as operations or steps used by a learner that will assist in the acquisition, storage, or retrieval of information (Rigney 1978; Dansereau 1985). Learning strategies have been applied to reading and problem solving in a first language (Chipman et al., 1985; Weinstein & Mayer, in press). More recently they have been applied to second language learning in studies that have shown that good language learners use a variety of strategies to assist them in learning new language skills (Cohen and Aphek 1981; Naiman, Frohlich, Stern and Todesco 1978; O'Malley, et al., 1985a; Rubin 1981). Effective second language learners, in common with effective readers and problem solvers in mainstream education, apply learning strategies when learning both language skills and content knowledge.

Studies in learning strategy applications have also indicated that students taught to use new strategies can become more effective learners. In a recent experimental study, second language learners were taught to use learning strategies for vocabulary, listening comprehension, and formal speaking tasks (O'Malley, et al., 1985b.) The results showed that learning strategy instruction was most effective for the more integrative language tasks which involved the use of academic language skills to understand or produce extended text.

We have identified three types of learning strategies through a review of the literature on learning strategies in first language reading and problem solving and second language learning, as well as through our own research. These types of learning strategies are:

- Metacognitive strategies, which involve executive processes in planning for learning, monitoring one's comprehension and production, and evaluating how well one has achieved a learning objective;
- Cognitive strategies, in which the learner interacts with the material to be learned by manipulating it mentally (as in making mental images or transferring previously acquired concepts or skills), or physically (as in grouping items to be learned in meaningful categories or taking notes on important information to be remembered);
- Social-affective strategies, in which the learner either interacts with another person in order to assist learning, as in cooperation or asking questions for clarification, or uses some kind of affective control to assist a learning task.

Learning strategies divided into this classification scheme are identified and defined in table 1. The learning strategies described are not limited to second language learning, but can also be applied to content learning in either a first or a second language by students in upper elmentary and secondary grade levels. In studying learning strategies used in different contexts, we have come to the conclusion that there are probably no unique strategies for learning a second language, although a subset of general learning strategies may be of particular use in language tasks (O'Malley et al. 1985a; Wong Fillmore 1985).

Some of the strategies listed in table 1 may be familiar to teachers under the term of study skills. Study skills describe overt behavior, such as taking notes, writing summaries, or using reference materials. Learning strategies, on the other hand, in general refer to mental processes which are not observable. A single learning strategy can result in several types of overt study skills. An example is transformation, a learning strategy in which the learner changes the material to be learned in some way. Ways in which the material can be thus transformed include notetaking, drawing a diagram, and writing a summary. Although this distinction between learning strategies and study skills is important theoretically, we do not believe that it is always necessary to differentiate them in practice.

Some learning strategies are particularly powerful because they can be used for many different types of learning activities. For example, two metacognitive strategies which can be applied to any type of learning are selective attention and self-evaluation. Students can use selective attention to assist comprehension by attending to the linguistic markers that signal the type of information that will follow. Some examples of phrases which serve as linguistic markers (Chamot and O'Malley 1986, 11) are:

Today we're going to talk about ..." indicates the main topic of the presentation. Markers such as "The most important thing to remember about....." indicates that a main idea is about to be presented. When students hear markers such as "For instance..." or "An example of......", they know that they can expect an example or a detail. And when students hear a marker such as "Finally, ..." or "In conclusion, ...", they can expect a concluding summary of the main points.

Self-evaluation assists learning by helping students decide how well they have accomplished a learning task and whether they need to relearn or review any aspects of it.

Two important and useful cognitive learning strategies are transfer and elaboration. They can be applied to all four language skills and to all types of content. Transfer can be used to increase comprehension by deliberately remembering what is already known about the topic, and by capitalizing upon any linguistic similarities that may exist between the first and second languages to assist comprehension. Similar to transfer is elaboration, in which students consciously. Interrelate concepts into new information or integrate new concepts into their existing knowledge structure. The following example illustrates these two learning strategies. Using transfer, the learner thinks, "Let's see. I have to read some information about the early history of California. What do I already know about California history? Well, the Spanish were there first, and then it belonged to Mexico, then there was a war between Mexico and the U.S., and now it's an important state..." The student goes on to read the assigned text, confirms previous knowledge, and also learns some new facts. During or after reading, the student may think, "Well, I didn't know that there were Russians in California, too. Let's see, how does this fit in with what I already know about the Spanish in California?" The student in this way relates new knowledge to previous knowledge by incorporating it into an existing conceptual framework.

The following teaching suggestions can help students practice the strategies of transfer and elaboration:

- Before starting a new lesson, discuss the topic with books closed. Ask students to tell everything they already know about the topic.

- After new information has been presented, ask students to relate what they have just learned to what they previously knew.

The social-affective learning strategies in table 1 can be helpful for many types of learning activities. Cooperation is a strategy which has been shown to have positive effects on both attitude and learning (Slavin 1983). It is particularly useful for LEP students because by working cooperatively on a task, students practice using language skills directly related to an academic task. Questioning for clarification is also important because students need to learn how to ask questions when they do not understand. Some LEP students may not know how or when to ask appropriate questions, or even that U.S. teachers expect students to ask questions. Self-talk is an affective strategy in which students talk to

Table 1

Learning Strategies Across the Curriculum

Metacognitive Strategies	
Advance organization	Previewing the main ideas and concepts of the material to be learned, often by skimming the text for the organizing principles.
Advance preparation	Rehearsing the language needed for an oral or written task.
Organizational planning	Planning the parts, sequence, and main ideas to be expressed orally or in writing.
Selective attention	Attending to or scanning key words, phrases, linguistic markers, sentences, or types of information.
Self-monitoring	Checking one's comprehension during listening or reading, or checking the accuracy and appropriateness of one's oral or written production while it is taking place.
Self-evaluation	Judging how well one has accomplished a learning activity after it has been completed.
Self-management	Seeking or arranging the conditions that help one learn, such as finding opportunities for additional language or content input and practice.
Cognitive Strategies	
Resourcing	Using reference materials such as dictionaries, encyclopedias, or textbooks.
Grouping	Classifying words, terminology, or concepts according to their attributes.
Notetaking	Writing down key words and concepts in abbreviated verbal, graphic, or numerical form during a listening or reading activity.

Table 1 (cont.)

Summarizing	Making a mental or written summary of information gained through listening or reading.
Deduction	Applying rules to understand or produce language or solve problems.
Imagery	Using visual images (either mental or actual) to understand and remember new information.
Auditory representation	Playing back in one's mind the sound of a word, phrase, or fact in order to assist comprehension and recall.
Elaboration	Relating new information to what is already known.
Transfer	Using what is already known to facilitate a new learning task.
Inferencing	Using information in the text to guess meanings of new items, predict outcomes, or complete missing parts.
Social and Affective Strategies	
Questioning for clarification	Eliciting from a teacher or peer additional explanation, rephrasing, or examples.
Cooperation	Working together with peers to solve a problem, pool information, check a learning task, or get feedback on oral or written performance.
Self-talk	Reducing anxiety by using mental techniques that make one feel competent to do the learning task.

themselves in order to allay anxiety by reassuring themselves about their own abilities. It has been used as a way of helping students overcome test anxiety, and could be used in any situation in which students feel anxious about a learning task.

Teachers can help their LEP students become more effective learners in general by showing them how to apply a variety of learning strategies to different activities that they may encounter in learning English as well as other subjects in the curriculum. Suggestions for learning strategy instruction include showing students how to apply the strategies, suggesting a variety of different strategies for the language and content tasks of the curriculum, and providing many examples of the use of learning strategies so that students will be able to generalize them to new learning activities in other classes and even outside the classroom (Chamot and O'Malley 1986).

Planning a CALLA Lesson

The three components of the CALLA model--academic language skills, subject matter content, and learning strategy development--can be integrated into a unified lesson by following suggested guidelines.

Establish both language and content objectives. Since both subject matter and language skills are to be taught, objectives for both must be specified. Questions that can guide the identification of content objectives are: What facts should students acquire as a result of this lesson? What concepts should they be able to extract from the facts? What skills and processes pertaining to this discipline will be developed by this lesson? Questions that can guide the identification of language objectives are: How will students use language to understand and remember the facts presented in this lesson? What language skills are needed in order to express an understanding of the concepts underlying the facts? How is language used to practice the skills and processes that are required in this subject area? What additional language practice can be added to this lesson to strengthen LEP students' academic language proficiency?

Determine appropriate learning strategies for the lesson. We recommend that metacognitive strategies (such as advance organization, selective attention, and self-evaluation) be included in each lesson because metacognitive strategies are believed to assist transfer of cognitive strategies to new learning tasks (Brown et al. 1983). Cognitive strategies selected depend on the language and content objectives of the lesson. For instance, if students will be acquiring facts through reading or listening, notetaking and/or summarizing may be effective strategies. On the other hand, if the lesson calls for classification, grouping may be an appropriate cognitive strategy, and in lessons where meanings must be gleaned from context clues, inferencing is a critical cognitive strategy. The selection of social affective strategies depends more on the type of classroom activities planned than on what is to be learned. Practice in asking questions for clarification and in cooperating with classmates in small group discussions or problem solving sessions can be included as a part of almost any lesson. Providing students with practice in anxiety reducing techniques such as self-talk can reduce the tension associated with a lesson's evaluation activities.

Use five organizing principles to sequence the lesson's activities. These five organizing principles are: preparation, presentation, practice, evaluation, and follow-up. During the preparation phase, the teacher gets the students ready for the lesson by helping them focus on the topic. This can be done by means of a brainstorming session in which students contribute all the information that they already know about the topic to be studied. Next, the teacher gives the presentation of the new material--either by explaining it, having students read it, showing a film or playing a tape. The new material must then immediately be practiced by the students so that they can actively manipulate both the concepts presented and the language skills needed to understand and express the new information. After students have had an opportunity to practice using the new material in a meaningful way, an evaluation of their understanding of the lesson should take place. This evaluation can be teacher initiated, it can be a cooperative peer process, or it can be a self-evaluation. Often the evaluation is built into the practice part of the lesson, so that students are constantly checking as they work on new problems. Finally, the teacher should plan for a follow-up activity that provides students with an opportunity to integrate the new concepts and skills acquired in the lesson into their existing knowledge framework.

CALLA lessons which exemplify the planning guidelines described in this section are included at the end of the chapters on science, mathematics, and social studies. These lessons are intended to show how learning strategies, content objectives, and academic language skills can be developed and practiced within a single integrated lesson.

Chapter 2

English Language Development Through Science

Science consists of content (facts and generalizations) and methods of discovery. Students studying science learn content concerned with topics such as the earth and the solar system, matter and energy, and living things. But they also learn basic scientific methods such as how to formulate hypotheses, how to propose alternative solutions, and how to evaluate proposed solutions. Accompanying the development of knowledge concerning the methods of science, students learn more fundamental skills such as observing, describing, classifying, using numbers, using time and spacial relations, measuring, infering, interpreting data, predicting, generalizing, and communicating findings (Blough and Schwartz 1974).

Methods of discovery are inseparably linked to the content of science. School science curricula present experiences that familiarize the students with both the content and methods of inquiry, and emphasize methods that will lead to independent discovery of the content. Thus, many science curricula are based on an inquiry teaching approach or an approach which emphasizes self-discovery of science content through increasing mastery of the methods of science. Many science curricula in schools typically attempt to engender in students a scientific attitude characterized by principles such as impartiality, curiosity, exploration, observation, deliberation, and precision.

Science at the elementary level may be left to the teacher's discretion in many schools, or science may be taught as a study of the student's immediate environment. Increasingly, schools are encouraged to provide extended opportunities for students to master a broader range of the content of science through discovery of scientific methods of inquiry (Orlich 1980). In an inquiry approach, students discover scientific concepts and principles for themselves by actively experimenting with and observing scientific phenomena. A complete elementary school science curriculum typically includes topics such as matter and its changes, rocks and the land, air and weather, measurement, plants and animals, heat and energy, light and sound, magnetism and electricity, space, forces and motion, conservation and the environment, and human biology (Rockcastle, McKnight, Salamon, and Schmidt 1980; Schmidt and Rockcastle 1982). Science at the elementary level is generally taught by the classroom teacher rather than by a science specialist. Science is probably underrepresented as a content area in the elementary school because relatively few elementary teachers are sufficiently trained in science education to feel comfortable teaching this subject.

At the secondary level, science is usually taught by teachers who have specialized in science education, and the curriculum consists of the natural and physical sciences. At the secondary level students generally focus on one area of science each year. The junior high school curriculum typically includes courses such as life science, earth science, and physical science. Biology, chemistry, and physics courses are offered by most senior high schools, and in some schools astronomy or zoology may also be available. Many science topics taught at the secondary level may have been introduced at the elementary level, but in higher grades a more in-depth understanding of the topic and scientific methods are developed. A simple comparison of the number of textbook pages devoted to a topic at different grade levels illustrates this point.

For example, a sixth grade science book devotes 8 pages to the topic of inherited traits in humans (Rockcastle et al. 1980), a junior high life science text has 43 pages on human heredity (Heimler and Lockard 1981), and a high school biology text has 91 pages of explanation on this topic (Curtis and Barnes 1985). The type size decreases and fewer illustrations are used as the grade level increases so that the language becomes denser and more decontextualized.

Research in inquiry science approaches for LEP students indicates that this content area can be particularly beneficial for developing both language skills and content knowledge. In various studies using inquiry approaches LEP students have not only been successful in developing science concepts, but their English proficiency has also shown significant improvement as a result of this type of instruction (De Avila, Cohen, and Intili 1981; Rodriguez and Bethel 1983). For these reasons, the CALLA model uses science as the initial content area of instruction for LEP students.

Science for LEP Students

Even though science activities which involve an inquiry approach and hands-on experiences lead to development of language proficiency, LEP students may still face language-related difficulties in science classes. Typical difficulties encountered by LEP students are in vocabulary, discourse, structures, and language and study skills.

Vocabulary. As in other content areas, a specialized vocabulary needs to be learned in science. In addition to technical terms, students must also learn that some nontechnical vocabulary has special meanings in science. This may be particularly difficult for LEP students who are familiar with a common meaning of a word, but do not realize that it has a special meaning when encountered in a scientific context. Words such as table, work, energy, nerve, sense, compound, mass, and respiration have precise scientific meanings as well as more general meanings. By the time students are in high school, the vocabulary load of science textbooks has become so technical that even native English speakers may find comprehension difficult. Words of Greek and Latin derivation are often used for scientific terms, and LEP students (especially those from a non-Western language background) may have difficulty in understanding the meanings of roots and affixes derived from these languages. The following example from a high school biology textbook illustrates the type of vocabulary density that students must contend with (Curtis and Barnes 1985, 245):

> The members of the kingdom Monera, the prokaryotes, are identified on the basis of their unique cellular organization and biochemistry. Members of the kingdom Protista are single-celled eukaryotes, both autotrophs and heterotrophs.

Discourse. Expository discourse is used to present science concepts. A series of related facts are typically presented, and students must make inferences from these facts to develop hypotheses and conclusions. In written or oral descriptions of experiments, language is organized in a sequence of steps which are to be followed in the order given. This type of discourse structure may be quite different from previous experiences LEP students have had with English narratives or texts requiring comprehension of material that is less cognitively demanding than the complex information often found in scientific texts.

Structures. Grammatical forms and structures in written science texts become increasingly complex in higher grade levels. Use of the passive voice, multiple embeddings, long noun phrases serving as subjects or objects in a sentence, if...then constructions, and expressions indicating causalities are some of the features of scientific prose that may be difficult for LEP students to comprehend. An example of a difficult structure is the following (Heimler and Lockard 1981, 199): "Growing a new plant from a part of another plant is called vegetative propagation." In a sentence such as this one, the student must read to the end to discover that the noun phrase which acts as the subject of the sentence is in fact a definition for a new term.

Language skills. All four language skills are required in science classes. In addition to the oral communication skills which accompany the experiential learning in an inquiry approach, students must also use receptive language skills to understand information presented orally or by the textbook. They must use productive skills, both oral and written, to participate in activities such as explaining a process, describing observations, classifying into categories, making predictions, and developing hypotheses. Table 2 identifies language skills typically required in science instruction. As this table shows, language skills needed to perform the functions of answering questions, asking for clarification, and participating in discussions are needed at all grade levels. As students move up into higher grade levels, they are expected to learn many important science concepts through listening to the teacher's explanations, which often include many fewer concrete referents than are generally used with younger students. In addition, higher grade levels demand greater literacy skills because students need to be able to read for information and to write, expressing what they have learned.

Study skills. Science study skills are similar in many ways to those developed in language arts and social studies. Students need to locate information in textbooks, reference books, and the library. They need to take notes on class presentations and on information in books, and to understand and use nonverbal information such as diagrams, charts, and tables. As in every subject area, students studying science need to develop test-taking strategies and skills.

These are some of the language areas in which LEP students may encounter difficulties in the science curriculum. Both ESL and mainstream teachers can help LEP students overcome these difficulties. ESL teachers can prepare LEP students for successful mainstreaming by developing science activities that practice language skills and teach learning strategies that help students understand and remember science concepts and processes.

Table 2

Language Skills Required By Science

Skill	Grades 1-3	Grades 4-6	Grades 7-
Listening			
1. Understanding explanations without concrete referents.	0	◐	●
2. Understanding demonstrations.	0	◐	●
3. Following directions for experiments.	0	●	●
4. Listening for specific information.	0	◐	●
5. Working with a partner on an experiment.	◐	●	●
Reading			
1. Understanding specialized vocabulary.	0	◐	●
2. Understanding information in textbook.	0	◐	●
3. Finding information from graphs, charts, and tables.	0	◐	●
4. Following directions for experiments.	0	◐	●
5. Finding information in reference materials.	0	◐	●
Speaking			
1. Answering questions.	●	●	●
2. Asking for clarification.	●	●	●
3. Participating in discussions.	●	●	◐
4. Explaining and demonstrating a process.	0	◐	◐
5. Working with a partner on an experiment.	◐	●	●
Writing			
1. Writing answers to questions.	0	●	●
2. Noting observations.	0	◐	●
3. Describing experiments.	0	◐	●
4. Writing reports.	0	◐	●

less emphasis → more emphasis

0 ◐ ● →

Mainstream or science teachers with LEP students in their classes can make science more accessible to these students by opting for an inquiry approach rather than relying exclusively on the textbook and oral explanations to develop science concepts. The remainder of this section provides examples that illustrate the many ways in which the interconnection between language and science can be exploited.

The discovery orientation of the science curriculum provides extensive exposure to cognitively demanding, context-embedded language settings. That is, the language used in science can be embedded in the context of demonstrations or practical experiments the students themselves carry out. The student can discuss abstract concepts like empiricism and at the same time have tangible and practical experiences that relate to the concept. The existence of context-embedded situations with cognitively demanding content and methods is a distinct advantage for language development because the student's experiences with language are supported by extra cues for meaning.

Another example of the connection between the science curriculum and language experience is that students must use language actively to reason through an observation from its inception to a conclusion. The process of analyzing a problem, describing, classifying, and other skills that are fundamental to science curricula are an integral part of language development. Science curricula often draw a parallel between this mental processing and what Piaget refers to as formal operations (Good 1977).

Science experiments invariably contain multiple steps that students perform through overt action, generally following directions presented either in a text or in a teacher's explanations. Students therefore have opportunities to use English as a medium of thought where they analyze the logical connection between successive steps of an operation. Language becomes the basis for their comprehension and retention of sequential activities that are essential to the science curriculum.

Students typically perform their experiments in pairs or in small groups, thereby providing multiple opportunities for interactive language use. Students may participate in discussions, test preliminary understandings of phenomena, receive feedback from peers, hear language used by peers, and evolve new concepts through these forms of interaction. This interaction through language and experience is the fundamental source of cognitive growth described in Piaget's writings and is a major reason for the importance of science for LEP students.

Students usually report on the findings of applying science methodology and have ample opportunities for constructing written or oral language reports. Students conduct studies in class either in pairs or in small groups, and discuss the approach to conducting their study in a context-rich setting due to the availability of objects used for the study. This provides an advantage to the language teacher because scientific reports are usually structured in a predetermined manner. The reports may contain a description of the rationale or hypothesis tested, the procedures, the findings, and an interpretation. Students therefore have organizational categories that can be used in identifying the language required to communicate the findings of their experiment. Once they identify the language required to communicate these organizational categories, they can determine if they have the necessary language skills to use in communicating the findings, and seek additional language as necessary.

One of the key principles to have emerged in recent studies of science learning is that students begin with a naive understanding of the way the world functions that can either support or conflict with instruction in science (Wittrock 1985). Students need opportunities to test out these belief systems and to receive immediate feedback on exploratory heuristics they employ in solving problems. One way to do this is to provide students with opportunities to work on problem solutions in small groups. Considerable success has been reported using this approach (Wittrock 1985). With LEP students, these opportunities to test out belief systems not only contribute to expanded understanding of the problem but also provide opportunities for using and developing English language skills.

The naive belief systems about how the world works and reasons for scientific phenomena may, in the case of LEP students, be related to their cultural background. In the area of science, as in social studies, the cultural background of the students can be used effectively for instruction. One way of incorporating students' home culture into science lessons is to have students investigate the scientific properties of familiar items from their own cultures.

We have provided an overview of the types of science activities which can develop both language skills and science content and methods. The next sections provide specific guidelines for developing science lessons (see sample lessons at the end of this chapter) and learning strategies which can be applied to both science learning and English language development.

Teaching Guidelines

As with other content-area lessons developed on the CALLA model, teachers planning science lessons for LEP students should identify content objectives correlated with the mainstream curriculum, and language objectives designed to develop the language skills required by science.

Content objectives should specify both the facts and generalizations of science and the processes and methods of discovery. Although many science topics are repeated at different grade levels, the depth and level of cognitive complexity increases with higher grade levels. Therefore, the CALLA model suggests that the amount of information and type of conceptual processing that is presented in a science lesson for LEP students should not be watered down, but be appropriate for their age and grade level.

Language objectives for science lessons are not difficult to specify because the nature of inquiry learning provides a particularly rich context for language development. Language objectives can include technical and nontechnical vocabulary development, discussion of students' predictions and observations, listening to or reading directions for an experiment, oral presentations and demonstrations, oral language development through interaction among students during an experiment, written reports, and practice in understanding and producing grammatical structures and discourse features found in science.

Learning strategies to be integrated into CALLA lessons should include strategies from all three categories of metacogntive, cognitive, and social affective strategies (see chapter 1). In addition to selecting strategies from the list presented in chapter 1, teachers can also find out what strategies students are already using successfully. One way to do this is to observe students working on a science task and ask them about the strategies or special techniques they are using to understand the material and to carry out the task. Students generally enjoy sharing their special strategies with each other, and can be encouraged to try out a variety of new strategies.

Teachers should plan an evaluation component for each science lesson, and should take care to separate as much as possible the testing of language from the testing of content. This may be easier to accomplish in science than in other content areas because science learning does not have to be demonstrated through paper and pencil tests that are heavily dependent on reading comprehension. Students can demonstrate comprehension of a process by completing an experiment or by making a drawing that illustrates it. Many science facts can be presented through pictures or diagrams, and students can choose the correct picture. In testing students' proficiency in the language of science, teachers should use the same kinds of tests as they would use in ESL classes, but modify the language to reflect the vocabulary, structures, and discourse of science. When testing for language, teachers should take care not to test for understanding of science concepts at the same time, because in analyzing incorrect answers it will not be apparent whether mistakes are due to language difficulties or to difficulties with the concepts.

The next section suggests ways in which teachers can help students develop effective learning strategies to assist in learning both the academic language and the concepts associated with science.

Learning Strategies

In addition to the natural connection between language and science, scientific content and methods also have a close relationship with many learning strategies. This means that learning strategies can be helpful in learning and remembering scientific content and methods. Learning strategies appropriate for science lessons are similar to those that can be applied to other areas of the curriculum.

For example, in developing specialized science vocabulary, scientific procedures for classification of concepts or objects lead to the use of grouping as an aid to learning. Imagery can also be a useful strategy for recalling new science words because so much scientific vocabulary relates to concrete items which can be pictured.

When students are listening to science explanations, they can use selective attention to help them remember the most important concepts, and inferencing can be used to assist in understanding new words and ideas. While students are watching a demonstration and listening to the explanation that accompanies it, they can use various learning strategies. They can use transfer of previous knowledge to assist in understanding, and after the demonstration they can use elaboration to relate what they have just seen to their general background understanding. In addition, imagery can be used to mentally perform the same operations that the teacher is demonstrating, and notetaking can serve to help them remember the procedures demonstrated. Later, as students perform experiments, they can remember the steps required to complete an activity through imagery or by picturing themselves performing steps.

Reading scientific text can be difficult even for native English speakers. Strategies to assist comprehension include advance organization, in which students skim section headings and study illustrations and diagrams to gain an overview of the material to be presented. Teachers can also provide for advance organization by giving students study questions prior to reading. These questions reveal not only the general topic, but also the important points that need to be discovered through reading. When students are looking for specific information in a science text, they can use selective attention to scan for particular facts. As with other reading in the content areas, the use of notetaking and summarizing will help students understand and remember the material read.

Writing science reports calls for the same types of learning strategies as writing reports for other content classes. First, students do organizational planning to have a clear idea of what form the report will have. In using this strategy, students first plan or outline the structure of the report and then identify the content needed for it. Then they can use resourcing and cooperation to find the needed information and language. As in other writing projects, students should expect to make several drafts of a science report before the final one. Self-evaluation is useful for improving and refining each successive draft.

Verbal interaction in the science class, as in other classes, frequently involves students in responding to teachers' questions and in explaining their understanding of the material being studied. Learning strategies that can assist this type of classroom speaking include selective attention to the specific content of a question, questioning for clarificaton in order to verify either a question or the student's understanding of the material, and auditory representation, in which students mentally rehearse a response before vocalizing it. When students describe a science process or do a group demonstration, organizational planning can help them prepare. By planning the sequencing of what they will say, students can check to see if they know the structures and vocabulary that will be required.

In an inquiry approach to science, student pairs or small groups of students can perform experiments cooperatively. Cooperation can be used by students in all aspects of their science learning, whether defining new vocabulary, pooling information after an explanation or demonstration, discussing the major points of a reading text, revising each others' draft reports, or, in general, learning from each other.

The application of many of these learning strategies is illustrated in the sample science lessons that follow in the concluding section of this chapter. In developing science lessons for LEP students, teachers should keep in mind that an inquiry approach to science instruction is preferred over a lecture or reading approach because active involvement in science activities not only develops concepts but also leads to increased language proficiency. The CALLA model for science instruction includes experiential science activities, language development activities, and practice in applying learning strategies to all aspects of science and language learning.

Sample Science Lesson 1

Rocks and Water

Language Objectives:	Oral language development, listening comprehension, note-taking, report writing
Science Objectives:	Find out the effects of moving water on rocks, find out the effects of rocks on water, develop the concept of a fair sample, practice observation and recording skills
Learning Strategies:	Metacognitive--selective attention, Self-evaluation. Cognitive--transfer, inferencing, imagery, note-taking. Social-affective--cooperation, questions for clarification
Grade Level:	Upper elementary
Materials for Each Group:	One paper or plastic bag; three jars of the same size, with lids; three paper towels; approximately thirty small, sharp stones or about 18-24 sharp fragments broken from a brick (some groups can have stones and others brick fragments); two tall glasses; water. For each student: a small notebook as an observation journal

Procedures:

Preparation

1. Discuss with students what happens to rain water. When it rains, where does the water go? Elicit that water runs downhill to form streams and rivers, and that these bodies of running water flow downhill into other rivers, lakes, or oceans. Write any new vocabulary on the board as it is discussed.

2. Ask students to speculate what happens as water moves over the land. What happens to the land? What happens to the water? Write student contributions on the board. Some students' predictions may be based on previous knowledge, and others may be hypotheses. The experimental activities that follow will serve both to illustrate previous knowledge and to test hypotheses.

Presentation

1. Explain to students that they will be working in groups to find out what water does to rocks and what rocks do to water.

2. Ask students to take notes on the following information and directions for the experiment. Remind students to use abbreviations, key words and phrases rather than sentences, and diagrams or drawings to clarify meanings.

When water flows over land in streams and rivers, it moves pieces of rock. When rock pieces move, they hit each other and they hit the bottom of the stream. Small bits of the rock pieces break off. The rock pieces become more rounded and less sharp. Small bits of rock dissolve in the water of the stream.

To find out what water does to rocks and what rocks do to water, we are going to do an experiment. These are the steps:

1. Make three piles of stones, equal in number. Each pile should have the same kinds of stones.
2. Put each pile of stones in a jar. Label the jars A, B, and C.
3. Fill jars A and B half full of water. Put the lids on all three jars and close them tightly.
4. Put jar A in a bag (to protect it in case it breaks).
5. Shake Jar A 1000 times. Do not shake Jars B and C.
6. Label the two glasses A and B.
7. Pour the water from Jar A into Glass A. Pour the water from Jar B into Glass B.
8. Label three paper towels A, B, and C.
9. Pour the stones from Jar A onto Paper Towel A, from Jar B onto Paper Towel B, and from Jar C onto Paper Towel C.
10. Observe the water in Glass A and Glass B. Write down your observations.
11. Observe the stones on the three towels. Write down your observations.

3. Explain to students what a fair sample is. (A fair sample is a rando selection of items.) Ask them to think of ways to make sure that the thre piles of stones are alike in range of stone sizes, shapes, and colors (Suggested method: Have students pick stones with eyes closed to ensur random selection.)

4. Provide students with format for observation journal. The format can b similar to the following, depending on the grade level:

Name
Date
Name of Experiment
Prediction (What I think will happen)
Procedures (What we did)
Results (What happened to the water; what happened to the stones)

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If the follow-up activities are carried out, the "Procedures" and "Results" sections of the report should be repeated and dated as necessary.

Practice

1. Divide students into small groups. Each group should compare the notes they have taken on the steps for the experiment, and ask questions for clarification for any steps that they do not understand or did not write down clearly. Have the groups prepare a master procedure card with all the steps for the experiment, and diagrams as needed.

2. When each group has a clear understanding of the steps to follow, have them decide which students will undertake each step, and write their names next to that step on the master procedure card. Students should take turns shaking Jar A, and should decide on how many shakes each should make, recording them as completed.

3. Provide each group with the materials listed above and have students carry out the experiment. Save the water in the glasses and the stones in the three piles for the follow-up activities.

4. Have students record the experiment in their individual observation journals (See #4 under "Presentation"). The expected results of this experiment are: the water in Glass A will be more clouded than the water in Glass B because of stone fragments dissolved in it through the action of 1000 shakes; the piles of stones on Paper Towel A will be more rounded (less sharp) then the other 2 piles of stones.

Evaluation

1. Have students share their observation journals with one or more classmates who worked with another group on the experiment to compare and discuss their entries.

2. Provide students with four to five stones or rocks of different shapes. Ask them to classify them according to how much contact with water they have probably had. (Smooth, rounded stones proably have had most contact, sharp, jagged stones the least. However, the hardness of the rock is also a factor--harder rocks are more resistant to the wearing effects of water.)

Follow-up

1. Have students replace the stones and water into their original jars and continue to shake Jar A 1000 times a day, recording predictions and results in their observation journals.

2. Have students bring in small samples of water from different sources such as: homes, lakes, mud puddles, water fountain, Jars A and B, fresh rain water, etc. Have them mark glass slides to identify the source of the water, and then put several drops of water on each slide. After the water has dried, have them compare and discuss the sediment remaining. (The more transparent the residue, the less rock/minerals dissolved in the water.) Discuss the differences between hard and soft water.

3. Have students do research and keep observation journals about the effects o water on land. A field trip to a stream before and after a rainstorm ca provide a first-hand experience with the effects of water on land. Student can share their journals and reports in small groups or with the whol class.

This lesson was adapted from Addison-Wesley Science, Book 4. Reading, MA Addison-Wesley Publishing Company, 1980.

Sample Science Lesson 2

Inherited Traits

Language Objectives: Oral language development, vocabulary development, notetaking, writing

Science Objectives: Understand basic principle of heredity by investigating inherited human traits

Learning Strategies: Metacognitive--selective attention, self-evaluation. Cognitive--transfer, inferencing, grouping, resourcing, notetaking, summarizing. Social affective--cooperation, questions for clarification

Grade Level: Junior or senior high

Materials: Chart of human traits for each student

Procedures:

Preparation

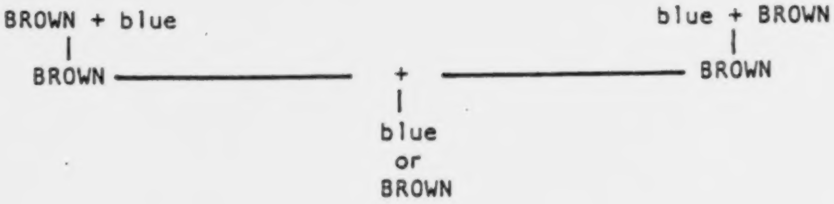
1. Ask students which parent or other family member they most resemble. Have students specify physical traits such as eye color, hair color and texture (curly, or straight), shape of mouth, dimples, smile, and spacing of teeth. Extend the discussion to shared traits among families (and, if appropriate, among ethnic groups).

2. Write the following words on the board and elicit what students understand them to mean: heredity, trait, gene. Write down student contributions. These suggested definitions will be confirmed or adapted as a result of this lesson.

   (For the teacher: heredity--the passing of characteristics from parents to children; trait--a characteristic that can be inherited; gene--the unit of inheritance that is passed from parents to children; child receives one gene from each parent for each trait.)

Presentation

1. Explain that some traits are stronger than others. They are called dominant traits. For instance, brown eyes are dominant over blue eyes. This means that if one parent has brown eyes and the other has blue eyes, the children will proably have brown eyes. Blue eyes are a recessive trait. A child gets one gene for each trait from each parent. A child with one blue-eyed parent and one brown-eyed parent will have a brown-eye gene and a blue-eye gene, but because the brown-eye gene is dominant, the child's eyes will probably be brown. However, if the child marries a brown-eyed person who also had one parent with blue yes, they may each pass a recessive blue gene to one or more of their children, resulting in blue eyes. Draw this table on the board to explain this process (dominant traits are written in capitals, recessive traits in lower case):



2. Discuss other traits, such as: attached or free ear lobes; right or lef handedness, color blindness (difficulty in distinguishing between red an green); tongue rolling (ability to curl tongue's edges).

Practice

1. Provide students with a chart listing traits, such as the one below. Discuss the traits to be sure students understand what they refer to.

2. Have students complete the first column of the chart by indicating whethe they have each trait.

3. Have students work in pairs to conduct a class survey for each trait on th chart, marking in the second column the number of classmates with the trait.

4. Have students sit in small groups to discuss their findings and make grou decisions about their predictions whether each trait is dominant o recessive. Each student should record the group's prediction in the thir column.

Evaluation

1. Provide students with textbooks on life science, reference books, an elementary-level library books on heredity. Have each group work togethe to check their predictions by using these resources. They should indicat whether their prediction was correct in the fourth column of the chart.

(For the teacher: Table of Traits)

DOMINANT	RECESSIVE
farsightedness	normal vision
normal vision	nearsightedness
dark hair	blond hair
dark or blond hair	red hair
color vision	color blindness
curly hair	straight hair
brown eyes	blue eyes*
free ear lobes	attached ear lobes
right handedness	left handedness
tongue rolling	non-tongue rolling

*other eye colors are the result of gene combinations

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Have the groups use the information on their completed charts to write brief summaries of their findings. These can be shared with the whole class, and any discrepancies resolved through checking references or consulting a science teacher.

Follow-up

1. Have students do a similar survey with family members and report the results to the class.

2. Have the class make a table showing the following information: traits most common and least common in the class; traits found in all students and in none of the students; any two traits always found together; number of dominant and number of recessive traits found in the class.

Sample Chart for Group Activity

Traits Found in the Class

Trait	I have it	Classmates with it	Prediction: Dominant? Recessive?	Was Prediction Correct?
Blue eyes				
Nearsighted				
Color blind				
Red hair				
Attached earlobes				
Left handed				
Curly hair				
Dimples				
Space between front teeth				
Tongue rolling				

Sample Science Lesson 3

(Can also be used as a mathematics activity.)

Measurement

Language Objectives:	Listening comprehension, oral language development, writing, oral reading
Science/Math Objectives:	Identify and use customary units of measurement, find perimeters; estimate length and distance
Learning Strategies:	Metacognitive--selective attention, self-evaluation. Cognitive--deduction, imagery, inferencing, summarizing. Social-affective--cooperation
Grade Level:	Elementary
Materials:	Table with rules for customary units of measurement (overhead or handouts for students); rulers, yardsticks and measuring tapes; chart to record measurements for each student

Procedures:

Preparation

1. Find out from students the units of measurement that they are accustomed to using. For students with schooling outside of the U.S., the metric system will probably be the most familiar. Explain to students that metric units of measurement are used for science and often for mathematics in the U.S., and customary units of measurement are used in everyday life. Metric units of measurement are used for science, mathematics, and everyday life in most other countries.

2. Write some customary units of measurement on the board. At first limit the variety of units to length and distance (inches, yards, feet, miles) and perhaps weight (ounces, pounds). Later you may wish to add units of capacity-ounces, cups, pints, quarts, gallons. Have students give examples of their understanding of these measurements. Sample questions: About how many inches long is a spoon? About how much does a lunchbox weigh in pounds?

Presentation and Practice

1. Provide students with a simple table that gives the rules for customary units of measurement, such as the one below. Find which students already know these rules.

Rules for Length and Distance

Symbol	Abbreviation	Name of unit	Plural form	Equivalent in other units
"	in.	inch	inches	
'	ft.	foot	feet	1 ft. = 12 in.
	yd.	yard	yards	1 yd. = 3 ft.
	mi.	mile	miles	1 mi. = 5280 ft.

2. Ask students to make up problems based on these rules. Sample problems might be: 12 in. = __ ft.; 24" = ___, etc. Write several problems on the board, then have students sit in small groups to make up additional problems. Then have the groups exchange problems and solve them cooperatively.

3. Explain that perimeter means the distance around an object. Use examples from the classroom to clarify.

4. Go over the rule for finding a perimeter with students, which is: To find the perimeter of an object or figure, add the lengths of its sides together.

5. Have students measure the perimeter of various objects in the classroom, such as: chalkboard, teacher's desk, table, window, classroom floor space, door, etc.

6. Review the names for these shapes: square, rectangle, triangle.

7. Tell students that you are going to describe a shape or object and give its measurements. They must make a picture of it, write the numbers, and then solve the problem. Possible shapes/objects to describe:

   I am thinking of a square. Each side is 35 inches long.

   Look at the door. The two long sides are 7 feet long. The top and the bottom are 3 feet wide. What is the perimeter?

   Make a picture of a triangle. It is a map of a park. One side is 500 yards long, one side is 550 yards long, and the third side is 350 yards. What is the perimeter?

Evaluation

1. Have students work in pairs to compare their drawings, the numbers they have written down, and their answers.

Presentation

1. Explain the meaning of estimate. Have students give examples of things they can estimate.

2. Provide students with a chart to record measurements. A sample chart is reproduced on p. 4.

3. Explain to students that they will be estimating some measurements by themselves and in a group, and then they will be doing actual measurements to check the accuracy of their estimates.

Practice

1. First have students work individually to estimate the measurements of the objects pictured. They should not do actual measuring yet, but write their estimates in column A.

2. Now have students sit in groups of four or five and discuss their individual estimates. The group should then decide on the best estimate they can make together, and each student should write the group estimates in column B.

3. Now have students work in pairs or threes to do the actual measurements and record them in column C.

Evaluation

1. Still in pairs or threes, have students compare, the group estimates with the actual estimates and write which is greater in column D.

Follow-up

1. Have students work in small groups to discuss the following questions: Can you think of an example in real life where you would want to know the perimeter of something? Why do you think customary units of measurement are used in the U.S. but not in other countries? Which system of measurement is easier? Why?

   Students should then write summaries of the group discussion individually. These individual summaries can then be read aloud for comments by the group.

2. Provide textbooks and library books on measurement. Have students work in small groups to discover additional facts about customary units of measurement, such as their origin, conversion rules between customary and metric units, rarely used units. The groups can then share their discoveries with the class.

Sample Measurement Chart

	A Your Estimate	B Group Estimate	C Actual Measurement	D Diff. Bet. A & C	E Diff. Bet. B & C
INCHES					
Your Thumb					
Your Pencil					
Your Science Book					
Your Ruler					
FEET					
Your Teacher's Chair					
The Class Chalkboard					
A Classroom Bookcase					
Your Teacher's Desk					
YARDS					
To The Water Fountain					
From Your Classroom To The Fire Exit					

(From Addison-Wesley's Language Development Through Content: Mathematics and Science, forthcoming.)

Chapter 3

English Language Development Through Mathematics

The major reason for studying mathematics is to learn how to solve problems. Through study of mathematics, students are prepared to solve problems they encounter in the world around them and problems they encounter in the further study of mathematics and sciences. To become effective problem solvers, students need to understand concepts, know basic facts, use computational skills efficiently, and select and apply appropriate problem-solving strategies (Eicholz, O'Daffer, and Fleenor 1985).

The mathematics curriculum develops students' capability to understand concepts through a variety of problem-solving experiences with manipulative materials or pictorial models prior to working with abstractions. Students develop a foundation in the basic facts and skills, as in addition or subtraction, through understanding a concrete model of the mathematical operation. They develop computational skill through practicing the procedure or factual knowledge under a variety of circumstances, and applying the factual information to problem-solving situations. Finally, students develop appropriate problem-solving strategies by having extensive opportunity to use techniques for solving realistic problems in a wide variety of different settings.

The scope and sequence of the mathematics curriculum from the upper elementary through the high school years begins with the foundation established in basic math facts in the earlier elementary years. In becoming acquainted with math facts in addition, subtraction, multiplication, and division, students exercise basic number problems until these operations are conceptually familiar and relatively automatic with up to four and five digits in numbers. In the middle to upper elementary years students begin the study of fractions and decimals, rounding out numbers and estimation; ratios, proportions, and percents. They may also have begun the study of graphing, probability, and statistics, and most certainly have begun their initial acquaintance with automatic calculators. Throughout this period, students will also have studied measurement, time, and money. In the intermediate years and through high school, students may study algebra, trigonometry, geometry, and sometimes calculus.

Mathematics for LEP Students

LEP students encounter difficulties with word problems more so than with other areas in mathematics because word problems are formulated in school curricula to be highly language dependent. Fewer serious difficulties can be expected among LEP students with basic math facts or computational skills. LEP students are not alone in having difficulty with word problems. Findings from the National Assessment of Educational Progress indicate that many nine-, thirteen-, and seventeen-year-old students cannot choose the correct computational procedures to solve word problems, even though they may understand the operations required to perform them. Teachers also have commented that the teaching of story problems is one of the most difficult tasks in the elementary school curriculum (Blankenship and Lovitt 1976).

LEP students are often exited from bilingual or ESL programs based on assessment of their general familiarity with English more than their specific knowledge of mathematics or other content areas. The LEP student who is mainstreamed may be familiar with general English vocabulary, be able to identify objects in English, communicate appropriately in social situations, and be able to decode simple reading passages at least close to his or her own grade level. The LEP student thus will evidence test performance that is considered adequate for entry into the mainstream of English language instruction. LEP students may nevertheless continue to have difficulty mastering content areas because of specialized language requirements that are unique to each subject, and because content area mastery requires that the student be able to use English as a medium of thought. The development of more advanced cognitive academic language skills may lag behind the development of social communicative language skills by as much as three to five years (Cummins 1984).

LEP students are often mainstreamed into mathematics classes before other subjects because of the mistaken belief that math does not depend on language. In fact, there are many language-dependent areas of math. Language skills typically required in mathematics classes are described in table 3, which indicates that skills in listening, reading, and speaking are typically required in grades 4-6 and may be pervasive in grades 7-12.

In our discussion of mathematics instruction for LEP students, we assume the students will have knowledge of most elementary mathematical concepts, basic facts, and fundamental computational skills in the four basic operations (addition, subtraction, multiplication, and division). Such students are at the middle elementary level or above. What we stress is instruction of the language required to solve mathematical word problems in English, and the problem-solving strategies that will lead to successful solution of word problems because these two areas present the most difficulty to LEP students at grade 4 and above.

The language of mathematics word problems creates difficulties for LEP students for a variety of reasons. The following discussion elaborates on some of these reasons.

Vocabulary. The language of mathematics is highly specific and lacks the redundancy typically found to assist comprehension with other types of language (Chamot 1985a; Chamot and O'Malley 1985; Secada 1985). LEP students may be easily confused by the specialized vocabulary that is common to mathematics. Mathematics has unique terms such as addend and quotient, and terms with specialized meanings such as altogether, round, and table (Cuevas 1984). To add to the difficulty of understanding this specialized language, the precision with which the language of mathematics is defined (round in mathematics has precise meanings) leads to the infrequent use of redundancy or paraphrasing of meanings as is found in other settings. The LEP student therefore has few cues to the meaning of words or phrases apart from the limited and often abstract context that is provided in the words and symbols in the problem statement (Dawe 1984).

Structures. LEP students may also be confused by the special grammatical constructions in mathematics. Examples of sentences which are commonplace in mathematics but do not appear in other content areas or in beginning-level ESL classes are the following: "Two numbers whose produc

Table 3

Language Skills Required by Mathematics

Skill	Grades 1-3	Grades 4-6	Grades 7-12
Listening			
1. Understanding explanations without concrete referents.	0	◐	●
2. Understanding oral numbers.	●	●	●
3. Understanding oral word problems.	0	◐	◐
Reading			
1. Understanding specialized vocabulary.	0	◐	●
2. Understanding explanations in the textbook.	0	◐	●
3. Reading mathematical notations and equations.	0	◐	●
4. Understanding word problems	0	●	●
Speaking			
1. Answering questions.	●	●	●
2. Asking for clarification.	●	●	●
3. Explaining how the answer was derived.	0	◐	●
Writing			
1. Writing verbal input numerically.	◐	◐	◐

less emphasis → more emphasis

0 ◐ ●

is 1 are reciprocals of each other." "The operations enclosed in parentheses are to be done first." "By what percent is 16 increased to give 24?". The language of mathematics is not often spoken in day-to-day activities so students have little opportunity to gain experience with this specialized language in other contexts.

Concept formation. With word problems, LEP students must conceptually process both the language and the mathematical problem before a solution can be reached. The student must be able to use English as a vehicle of thought and to solve the problem in English, a language the student may not understand well at this point in his or her education. Many word problems require formal operations or the ability to think abstractly and to manipulate concepts through language. If the student's thought processes are not automatic in the language in which the problem is expressed, but require deliberation due to confusion over unfamiliar meanings of words or phrases, the student's attempts to solve the problem will be delayed if not interrupted altogether. LEP students in first year algebra courses have been noted to misinterpret problem statements and to require extra linguistic processing time that prevented their completion of timed problem assignments (Mestre 1984).

Cultural differences. Other less obvious difficulties in understanding math appear on inspection of the type of mathematics instruction LEP students may have received in their native country. Children in many countries are taught to reverse the positions of the divisor and dividend in division problems, and use a period in place of a comma in writing the numerals for multiples of a thousand (Secada 1983). Students in almost every country outside the United States study the metric system exclusively and thus encounter difficulty with the customary units of measurement (inches, miles, quarts, pounds, etc.) and are unaccustomed to the emphasis placed on fractions in U.S. schools. A measurement system in which every unit has meaning when divided by ten has little use for fractions. Cultural differences have also been noted in the conceptual strategies students apply to mathematics. The previous mathematics training of recent immigrant Chinese students has been noted to emphasize accuracy and speed based on memorization of rules and formulas, in contrast to the emphasis on the analytical and conceptual basis of mathematics in current U.S. curricula (Tsang 1983). While these difficulties do not affect word problems exclusively, they are important to identify when children appear to understand the meaning of the problem but persist in finding an incorrect solution.

Nonlanguage factors. The foregoing are unlikely to be the only difficulties LEP students encounter with word problems. Studies with native English-speaking students indicate that reading ability accounts for only a small portion of the errors in word problems (Knifong and Holtman 1977). Children with normal reading scores who were able to identify both the setting and the question in word problems were often unable to work the problem or even know where to start. These students experienced procedural, computational, and clerical errors. For these and other students like them, an instructional approach may be required that evokes alternative problem-solving strategies and checks for validity or accuracy.

Teaching Guidelines

In recognizing that many students have difficulty solving word problems, mathematics curricula and textbooks often provide advice to the student that is intended to assist in obtaining the solution to the problem. This advice typically takes the form of guidelines such as the following (Eicholz et al. 1985):

- Understand the question
- Find the needed information
- Choose a plan
- Solve the problem
- Check the answer.

While these inducements may have meaning for native English speakers, such guides to problem solving probably have little significance for LEP students. How does the student go about understanding the question when the issue of primary concern is determining the meaning of words presented in an abstract context? What information is needed and what is a plan? How does one develop a plan, and what importance does a plan have for solving the problem? What does it mean to check an answer? While useful for many native English-speaking students, these recommendations for problem solution are no substitute for a precise description of the techniques that can be used in solving mathematical problems.

The Cognitive Academic Language Learning Approach (CALLA) to teaching mathematics to LEP students is derived from three key ideas. The first is the direct linkage for LEP students between the language of word problems and the path to their solutions. That is, an understanding of the language is a minimum condition for solving the problem. While reading at grade level is no guarantee that a student will be able to solve mathematical problems, the student who cannot understand the words or the phrasing in a word problem has little chance of reaching the correct solution. Thus, guidelines must be established that will enable teachers of LEP students to build the necessary language supports for students to be able to understand the language in word problems and to begin to use English as a vehicle for thought.

The second key idea concerning mathematics for LEP students in CALLA is the importance of making the steps required for problem solution explicit. That is, LEP students need to know what to look for in a problem statement that will help them understand the problem, and they need cues that will help them find the needed information required to develop a plan and solve the problem. Although students in some cases may reach an intuitively correct answer to a word problem without conscious awareness of the steps they undertook in reaching the solution, making the steps in problem solution explicit is especially important for students who encounter word problems for which the correct answer is not immediately apparent. And that probably means most word problems for most LEP students. CALLA provides students with explicit directions on how to perform these and other steps necessary for solving the problem.

The third key to solving word problems is the role of learning strategies. Learning strategies assist LEP students to perform successfully each of the steps that lead to problem solving. Strategies can be selected from metacognitive, cognitive, and social/affective groupings for this purpose (as identified in chapter 1). The way in which teachers can use learning strategies with these steps is discussed next.

In the following discussion, we identify implications for instructional practice in mathematics that derive from CALLA. We have merged recommendations based on language approaches with recommendations based on an analysis of learning strategies used in problem-solving. The principal objectives of these activities are to provide students with the language skills and the conceptual strategies necessary to solve mathematical word problems. The organizing framework for our discussion is the discrete steps that students may follow in solving word problems.

Understand the question. The first step in a student's attempt to solve word problems is to understand the question, which requires an understanding of the words and phrases used in the problem statement. Familiarity with the meaning of individual words and phrases in word problems can be developed in a number of ways. Students can be asked to contextualize math words by making up sentences with them, and they can be challenged by puzzles or matching items to test their recall. The ability to use these words as part of their own vocabulary can be instilled by having students write their own word problems, and share these with their peers. Small group discussion will allow them to share their own word problems and further use mathematical language.

Students can demonstrate their understanding of the word problem in different ways, one is to rewrite or paraphrase the question so that it makes sense to them. Exercises in which students rewrite the question are a useful way to provide students with experience in thinking through the meaning of the question. A second way that students can demonstrate their understanding of the problem is by drawing a picture or describing verbally the way in which they have represented the problem internally. This will make the student's internal representation of the problem explicit. However, it may be unnecessary to ask students to draw a picture of their representation of the problem unless they are having difficulty in solving the problem.

Find the needed data. There are three types of information students need to identify in word problems. The first is the key numbers. Word problems often contain irrelevant distractor numbers that are not needed to solve the problem. If the student has established an accurate representation of the problem, the necessary information to solve the problem can be more easily identified. Exercises in which students circle required numbers and cross out distractors are helpful in finding the necessary information.

A second kind of information the students need to identify in word problems is important words that might cue the operation that will be used. Words such as *altogether*, *sum*, and *total* suggest the use of addition, while words such as *difference*, *more than*, and *greater than* cue that the correct operation to use is subtraction. Students can be instructed to attend selectively to these types of words in word problems so they will be able to determine the correct operation called for by the problem. Exercises that require the student to circle key words that cue the operation to be used may be important for LEP students.

The third type of information students need to identify is words needed to solve the problem. Students need to learn to ignore nonessential words which they do not understand and to focus on the essential words which they do understand. Exercises can be used in which students cross out the nonessential words.

Choose a plan. Based upon the mathematical operation the student has identified and an understanding of the question, the students may be able to choose a plan for solving the problem. In some cases, students will be able to solve the problem in their head. Students who are able to solve the problem in their head should be encouraged to do so without further delay. If they can solve the problem by writing it down on paper, they should also be encouraged to proceed.

Students who have difficulty in selecting a plan that will result in an answer should review steps one and two to see if a simple rereading of the problem will result in an acceptable plan. Then students will have an option between plans that are appropriate for working alone, and plans that are appropriate for working with other students.

- Working alone. Students who work alone may use a variety of approaches to develop a plan. The following may be helpful.

  --Draw a picture illustrating the internal representation of the problem;

  --Make a table entering the key numbers or showing important relationships;

  --Guess at the answer by substituting in different values and check to see if they make sense.

- Working in a small group. Students who work in small groups (between three and four students) may wish to use some of these approaches to develop a plan.

  --Read the problem aloud to friends. Sometimes simply reading the problem aloud is sufficient to give the student a new awareness of the problem;

  --Paraphrase or explain one's understanding of the problem. Obtain feedback from friends on the accuracy of the understanding of the question and the selection of key words and numbers;

  --Ask friends to explain their understanding of the problem. Have them focus on their understanding of the question and selection of key words and numbers. Then have them focus on how they selected a plan. Do not ask them to give the answer.

Whether students work alone or in small groups, brainstorming is necessary in order for them to identify alternative plans and test them out against their understanding of the problem.

Find the answer. In this step the students will perform the calculations required to solve the problem.

Check back. Students should check the entire process of problem understanding and solution, not merely the calculations performed in getting the answer. The students will check their understanding of the question, and verify that the answer they have obtained makes sense in terms of the original representation they had of the problem. They will also check to determine that they have used the key numbers and key words consistent with the plan that was formulated.

Learning Strategies with Word Problems

Learning strategies with word problems are special techniques students use in actually performing the steps involved in successful problem solution. Successful problem-solving techniques can be identified and taught to LEP students to assist their understanding of the language and of the problem. If specific problem-solving techniques can be linked to steps like those noted above (understand the question, etc.), the mere suggestion of the steps would have a new and special meaning for the LEP student. The student would then have a varied range of strategies that are cued by each of the more explicitly defined steps, and could apply these strategies with other attempts at problem solution. Through repeated exercises with these strategies, the student would have a ready repertoire of approaches for understanding the language of mathematics as well as for solving word problems.

One way to identify the learning strategies useful for solving mathematical problems is to ask students to think aloud while they are in the process of solving problems. Studies in which the path to problem solving has been made explicit by students have been helpful in suggesting techniques that may be useful with LEP students. For example, students nominated by teachers as effective problem solvers understand problems through construction of an internal or external representation of the problem (Yackel and Wheatley 1985). Students often report that these representations are visual rather than verbal and may consist of a pattern or an arrangement of objects. Suppose, for example, that students are presented with the following problem:

> John is 8 years younger than Mary. John is 12. How old is Mary?

An internal visual representation of this word problem might take the form of a boy who is the younger brother of an older sister, or a boy who is smaller (and thus younger) than a girl. The type of representation selected by the student will depend upon the amount and type of prior knowledge that he or she has about the problem. For example, a male student with an older sister may have a variety of additional connotations associated with the term "older sister" that would serve to fix in mind the importance of finding a solution to the word problem that results in a number which is larger than 12.

Teachers can ask their LEP students to identify their own strategies and thought processes in problem-solving by asking them to think aloud as they work out the solution to a problem. Students can be given mathematical problems of different kinds, seated in small groups, and asked to describe their problem solving process. They can also be asked how they performed different steps in the problem-solving sequence. Our experience has been that students who are intermediate in English proficiency are generally quite capable and interested in expressing the kinds of strategies they use in understanding English. We would expect this same willingness to apply in expressing the strategies they use in solving mathematical word problems. A think-aloud activity provides practice in actively using the language of mathematics in addition to clarifying the processes students use in problem solving.

Word problems typically are encoded or understood and retained in terms of meaning that may be contained in a single word or paraphrase. The meaning is therefore encoded in abstracted form rather than in complete sentences which parallel the original phrasing in the problem statement. As with the representation of word problems, the meaning is also heavily dependent on the student's prior knowledge of the subject. Furthermore, the degree of meaning is related to the number of elaborations or conceptual linkages the student makes between the problem content and prior knowledge. As in the example noted above, the student who himself is the younger brother of an older sister will have far more connections or linkages than a student who is an only child or one who has an older brother. These elaborations broaden the student's perception of the problem so that an accurate interpretation of the problem statement is more likely to occur. An accurate understanding of the problem is critical for identifying the data that are needed to solve the problem, i.e., for identifying the key numbers required for the problem solution. Word problems often introduce ancillary numbers that serve as a distractors from the key numbers. One of the student's important tasks is to differentiate key numbers from these ancillary numbers. Teachers can assist students in gaining an accurate understanding of the problem by using selective attention to focus only on the numbers that are needed in the solution to the problem.

Other studies note that effective problem solvers maintain a reflective view of their own problem-solving processes. They analyze the related information they might have, look for possible solutions, and check the accuracy of alternate solutions (Dirkes 1985). Such metacognitive awareness, or executive control over problem-solving, provides the student with flexible and autonomous control over the learning process. In addition to metacognitive control, an effective problem solver will brainstorm a variety of alternate plans or solution strategies, activate what he or she has learned, try the plan out on the problem at hand, and evaluate its application to the solution (Dirkes 1985). The student's evaluation of the plan must be performed with respect to the original problem representation rather than to the simple computational procedures needed to solve the problem (Noddings, Gilbert-MacMillan, and Leitz 1983). In the problem noted above, the student could subtract 8 from 12 correctly and obtain the incorrect but mathematically accurate answer of 4. Evaluation with respect to the original problem representation ensures that the solution is accurate for the original problem statement, that the correct mathematical operation is used in the solution, and that all of the parts of the problem needed in the solution have been considered. Teachers can caution their students to check the answer with respect to their original understanding of the problem in addition to checking the accuracy of the computation.

One of the strategies students should be aware of in reaching a problem solution is that they may work on the problem in cooperation with other students. Recent studies of problem-solving in small groups indicate that groups of three and four students may be more effective in ensuring that students have an accurate representation of the problem than students working alone or in pairs (Noddings et al. 1983). One major function that small groups can serve is to provide feedback on preliminary attempts to represent the problem. Students will be led to examine their own information and strategies based on group challenges, disbelief, or affirmation. A second major function of small groups is to supply background information that individual students may not possess. A strategy such as "select only the numbers that are needed to solve the problem" may have little meaning if the student does not have enough information to identify the relevant numbers. Lack of adequate background information is one of the major obstacles to successful problem solution among native English-speaking students (Hart 1985), and is an even greater obstacle to students from other cultures. A third major function served by groups is that effective problem solvers who verbalize their own problem-solving processes are modeling the avenues to solution for less effective problem solvers. The students can profit from observing each other's thought processes as they are verbalized. These externalized verbalizations of problem-solving processes are more likely to occur in small groups of three and four than in pairs (Noddings et al. 1983). As a final benefit, students who work in small groups, independent of the teacher's immediate control, are taking responsibility for their own learning and rehearsing independent working skills. Basically, a student does not have to work alone to become an independent learner. Teachers of LEP students can capitalize on the effectiveness of small groups in mathematics by encouraging cooperation in reaching problem solutions.

Sample Mathematics Lesson 1

Oral Word Problems

Language Objectives:	Listening comprehension; vocabulary development; oral language development
Math Objectives:	Preview addition word problems; practice solving oral word problems
Learning Strategies:	Metacognitive--Selective Attention. Cognitive--Notetaking. Social/Affective--Questioning for Clarification
Grade Level:	Elementary
Materials:	Picture or transparency of scene depicting variety of countable objects or people. Work sheet with spaces for problems. Vocabulary list and sample math textbooks

Procedures:

Preparation

1. Show the picture or transparency. Discuss with students, asking them to identify different items in the picture. Provide additional vocabulary where necessary.

2. Introduce math vocabulary used to ask questions: How many? How much? What?

3. Have students ask each other how many of each different item appears in the picture.

4. Introduce math vocabulary related to addition:
   add, and, plus, put together,
   in all, altogether, total, sum, both,
   equals, is, are

5. Explain to students that they will hear some problems related to the picture or transparency. They must listen carefully for the math words that tell them what to do. They should write down the numbers that they hear.

Presentation

1. Read simple problems based on the picture. For example, if the picture shows a classroom with two aquariums and children exchanging fish between the aquariums, typical problems could be the following:

There are two aquariums in the classroom. Two children take care of one aquarium, and three children take care of the second aquarium. How many children take care of both aquariums?

The children empty the fish from the first aquarium. Lisa now puts three fish into this aquarium and Jose puts four fish into the same aquarium. How many fish are now altogether in this aquarium?

Marta takes three fish from the second aquarium. She's going to put them into the first aquarium, which already has seven fish. What will the total number of fish be in the first aquarium?

2. After each problem, give students an opportunity to ask questions for clarification. Provide them with model questions, such as:

   What does _____ mean?
   How many _____ are there?
   Could you repeat the numbers, please?
   Do I have to add or subtract?

Evaluation

Give students a chance to work out the answers to the problems, then call on individual students to read their problems and answers. If necessary, provide a model for the oral statement of the problem. Example:

Eight plus three equals eleven. OR
Eight and three are eleven. OR
The sum of eight and three is eleven.

Follow-up

1. Provide students with worksheets containing additional word problems in which there are blanks where the math vocabulary words introduced in #2 and #4 of the Preparation section should be. Read the complete problems aloud and have students fill in the blanks with the missing information. Students can solve the problems either individually or as a group activity.

2. Using the illustration, ask students how many math questions they can ask about it. Examples of questions based on the picture of the two aquariums: How many rocks are there in each aquarium? How many rocks altogether? How many children are at each aquarium table? Which table is bigger?

3. Have students draw their own pictures to be used for math word problems. They can then sit in small groups, show and describe their pictures, and ask other students to make up or solve word problems for them.

(From Addison-Wesley's Language Development Through Content: Mathematics and Science, forthcoming.)

Sample Mathematics Lesson 2

Write Your Own Problem

Language Objectives: Writing, listening comprehension, oral reading, oral language development

Math Objectives: Practice writing word problems and solving oral word problems

Grade Level: Upper elementary and secondary

Learning Strategies: Metacognitive--Organizational Planning, Self-Evaluation. Cognitive--Resourcing, Note-taking, Summarizing, Elaboration. Social/Affective--Cooperation

Materials: Work sheets with spaces for word problems. Math vocabulary lists. Grade level math textbooks

Procedures:

Preparation

Explain to students that they are going to write some word problems of their own and solve each others' word problems.

Presentation

1. Tell students to organize their ideas first. This requires two steps. First, students suggest math facts and write them on the board. If necessary, remind students how to say longer numbers (e.g., one thousand two hundred and sixty-four). Second, students suggest their own word problem to go with the facts.

2. After students have organized their ideas, they are ready to write their problems. This also requires two steps. First, students write the story that they thought about. Second, students write a question to go with the story. Call on students to write sample stories on the board, then call on different students to write questions for the stories. Remind students to use math vocabulary words that tell which math operation to use.

Practice

1. Provide students with a worksheet with spaces for three or four problems. Example:

Math Fact: ______________________________

Story: ______________________________

____

Question: ______________________________

Provide them with vocabulary lists and sample math textbooks to use as resources for writing their word problems.

2. After writing their word problems, have students sit in small groups and take turns reading their problems to each other. While one student is reading aloud, the others in the group should take notes on the numbers involved, and then solve the problems.

Evaluation

1. After solving the problems, students should work together to check their answers. Calculators may be used.
2. After the answers have been checked, have students complete short questionnaires to evaluate their own progress in understanding and solving word problems. Sample questions to answer:

   How many correct answers did I have?

   Which problems were easy?

   Which problems were difficult?

   Were the difficult problems difficult because of the language or because of the math?

Follow-up

1. Have students sit in small groups to discuss the following questions: Is it easier to write word problems or to solve someone else's? Why? When you write a word problem, what can you do to make it easy to solve? What can you do to make it difficult to solve?

   Then have them write individual summaries of the group discussion. The written summaries should then be shared with the group.

2. As an assignment, have students write three word problems about something that their family does, following the same format practiced in class. They should not solve the problems or put their names on them. In class, shuffle the papers and distribute them to students, who should sit in small groups to work cooperatively to solve the problems and to guess who wrote the problems.

(From Addison-Wesley's Language Development Through Content: Mathematics and Science, forthcoming.)

Sample Mathematics Lesson 3

Understand the Problem--Rewrite the Question

Language Objectives:	Reading comprehension, vocabulary development, oral language development
Math Objective:	Identify questions in word problems
Learning Strategies:	Metacognitive--Selective Attention, Self-evaluation Cognitive--Transfer, Summarizing, Resourcing. Social/ Affective--Cooperation
Grade Level:	Elementary
Materials:	2 worksheets with grade--appropriate word problems. Math textbooks from different grade levels

Procedures:

Preparation

Ask students to give as many phrases or sentences as they can that ask math questions: Review math vocabulary used to ask questions.

> Examples: How many/much? How long/short/high/far/? What?
> Solve the problem. Find the answer.

Presentation

Write a simple word problem on the board and have students identify the question then underline it. Example:

> In the Gomez family, 3 people are adults and 4 people are children. How many people are there in the Gomez family altogether?

Practice

1. Provide students with a worksheet containing similar word problems. They should read them silently, identify the question, then underline it.

2. Next, have students work in pairs, taking turns reading only the questions for the problems to each other. Then they should discuss how to find the answer, work the problem cooperatively, and finally write the answer.

3. After this practice in identifying the questions for word problems, write another word problem on the board. After students have identified the question, ask for volunteers to orally transform the question into a statement. Then rewrite the question as a statement, leaving a blank for the answer. Example:

   Tran has 22 fish in his aquarium and Nhu Trinh has 32 fish in her aquarium. What is the total number of fish in both aquariums?

   The total number of fish in both aquariums is ____.

4. Provide students with another worksheet containing similar problems. They should read them silently, identify the question, and rewrite it as a statement with a blank for the answer.

5. Have students work in small groups of three, reading the statements they have written to each other and solving the problems together.

Evaluation

Have students work together to check their answers.

Follow-up

1. Discuss the following questions: How many math questions can you ask about people and things in our classroom? (Examples: How many people are there with brown eyes? What is the total number of chairs?)

   How many math questions can you ask a friend? (Examples: How old are you? How old will you be in 5 years? How many brothers and sisters do you have?)

   This can be used as a brainstorming session in which the teacher writes all suggested questions on the board, then leads a discussion of which questions are appropriate in different circumstances. For instance, some types of personal questions might be considered appropriate for children, but rude for older students.

   Have students work in groups to write summaries of the class disscussion.

2. Provide students with a collection of math books from different grade levels. Have them work in pairs or teams to go through the math books, find pages with word problems, identify the questions, and rewrite them as statements. It is not necessary to solve the problems if they are too difficult linguistically or mathematically; the purpose is to provide practice in selective attention (to the question) and transformation (from a question to a statement).

(From Addison-Wesley's Language Development Through Content: Mathematics and Science, forthcoming.)

Sample Mathematics Lesson 4

Identify the Operation

Language Objectives:	Reading comprehension, vocabulary, oral language development
Math Objective	Identify key math words in addition word problems
Learning Strategies:	Metacognitive--Selective Attention, Self-evaluation. Cognitive--Transfer, Note-taking, Resourcing, Summarizing. Social/Affective--Cooperation, Questions for clarification
Grade Level	Elementary
Materials:	Work sheet with word problems

Procedures:

Preparation

Ask students to think of as many words as they can that mean to add. Write them on the board to review math vocabulary related to addition.

Examples: add, and, plus, put together, in all, altogether, total, sum, both.

Presentation

1. Write several simple word problems on the board. Have students identify the questions, then ask for volunteers to rewrite the questions as statements with blanks for the answers.

2. Ask students to look for the key words that tell which math operation to use. Have them circle these words. Examples:

   How many children are there in all in the 3 families?
   What is the total number of students in both classrooms?
   How much did Mr. Gomez pay altogether for the tickets?

Practice

1. Give students a worksheet with addition word problems. They should read them silently, rewrite the questions, and circle the key words that indicate which math operation to use.

2. Students work in pairs or small groups, taking turns reading the questions and indicating the key words. Then they discuss how to find the answers, asking questions for clarification as needed, work the problems cooperatively, and write the answers.

3. Have students write one or two simple sentences that give information about numbers. Example: Marta has four cookies and Tran has three cookies. Then have students exchange papers and write questions for the problems. Exchange papers with different students, so that each student has a completely new paper. Now students can rewrite the questions as statements, leaving blanks for the answers, circle key math operation words, and solve the problems.

Evaluation

Have students sit in small groups to discuss and correct their problems. Calculators may be used.

Follow-Up

1. Have students sit in small groups to discuss the following questions: Do you need to understand every word in a math problem in order to solve it? Which are the most important words to understand?

   Then have students write individual summaries of the discussion and share them with the group.

2. Provide students with math textbooks appropriate to their grade level and to lower grade levels. Have them work cooperatively to find word problems and identify the questions. Have them make a list of all the words they find that indicate which math operation to use. The list can then be divided into groups of words related to each of the operations included.

(From Addison-Wesley's Language Development Through Content: Mathematics and Science, forthcoming.)

Sample Mathematics Lesson 5

Word Problems: Solving the Problem

Language Objectives: Listening comprehension, vocabulary development, oral language development

Math Objectives: Review elementary algebra, practice solving word problems requiring algebra

Learning Strategies: Metacognitive--selective attention, self-evaluation. Cognitive--note-taking, transfer, grouping, imagery, summarizing. Social/affective--cooperation

Grade Level: Junior and senior high school

Materials: Worksheet with word problems

Procedures:

Preparation

1. Review vocabulary terms such as variable, alegebraic, expression, equation, and evaluating algebraic expressions (see definitions at the end of the lesson). Give students an opportunity to tell what they know about these terms.

2. Review that a word problem may be solved by replacing the words used to express the problem with a formula. Specific examples are as follows--

Problem in words	Equation
5 more than n is 8	$n + 5 = 8$
6 times n equals 12	$6n = 12$
8 less than x equals 2	$x - 8 = 2$
One half of y equals 3	$y/2 = 3$
The number increased by 2 equals 9	$n + 2 + 9$

3. Review that an equation can be solved by rearranging the terms, as in the following--

Equation	Solution
$n + 5 = 8$	$n = 8 - 5 = 3$
$6n = 12$	$n = 12/6 = 2$
$x - 8 = 2$	$x = 2 + 8 = 10$
$y/2 = 3$	$y = 3(2) = 6$

Ask students to make up their own examples and check the answers in pairs.

4. Review that an equation with two unknown variables may be solved through substitution if one of the variables can be expressed in terms of the other. For example--

Equation One	Equation Two	Substitution
$x + y = 45$	$y = 2x$	$x + 2x = 45; \quad 3x = 45$ $x = 45/3 = 15$
$2n + 3z = 50$	$z = n + 3$	$2n + 3(n + 3) = 48$ $5n = 45; n = 15$
$(m + 5n)/3 = 15$	$n = m - 3$	$m + 5(m - 3) /3 = 15$ $(6m - 15)/3 = 15$ $6m - 15 = 15(3)$ $6m = 45 + 15;$ $m = 60/6 = 10$

Presentation

1. Review the steps required to solve a problem. Provide practice on these steps with simple word problems. The steps are:

Steps in Solving Problems	Illustration
a. Understand the question	a. Read the problem. What number must be found?
b. Find the needed information	b. Determine the important numbers. What operation(s) is suggested? What are the unknown variables? What basic information is provided?
c. Choose a plan	c. Use the numbers and the operation to write an equation for the unknowns. Write a second equation showing the relationship between the unknowns. Substitute in the first equation so that only one variable is an unknown.
d. Solve the problem	d. Solve the first equation for the single unknown.
e. Check the answer	e. Substitute the numbers into the original equation. See if they make sense.

2. Solve some simple word problems using the steps in No. 1.

   The length of a rectangle is five times its width. The perimeter of the rectangle is 24. Find the length and width.

   - Understand the question: the unknowns are the length (L) and the width (W).

   - Find the needed information: 2L + 2W = perimeter = 24; L = 5W.

   - Choose a plan:
     First equation: 2L + 2W = 24
     Second equation: L = 5W.
     Substitution: 2(5W) + 2W = 24

   - Solve the problem: 10W + 2W = 12W = 24; W = 24/12 = 2

   - Check the answer: L = 5W = 5(2) = 10; 2L + 2W = 2(10) + 2(2) = 20 + 4 = 24

   The total mass of two cereal boxes is 1000 grams. One box contains 300 grams more than the other. Find the number of grams of cereal in each box.

   - Understand the question: the unknowns are the weights of each box (W1 and W2). Students can make a mental or actual picture of the two cereal boxes.

   - Find the needed information: W1 + W2 = 1000; W2 = W1 + 300

   - Choose a plan:
     First equation: W1 + W2 = 1000
     Second equation: W2 = W1 + 300
     Substitution: W1 + (W1 + 300) = 1000

   - Solve the problem: 2W1 + 300 = 1000; W1 = (1000 - 300)/2 = 350

   - Check the answer: W2 = W1 + 300 = 350 + 300 = 650; 350 + 650 = 1000

Practice

1. Provide students with a worksheet containing similar word problems. They should read them silently and solve and check the problems using the steps to solving problems illustrated above. Additional sample problems are as follows:

   - The sum of two consecutive numbers is 397. Find the numbers.

a. Understand the question: the unknowns are the consecutive numbers. Students can make a number line to help in developing a mental image of the problem.

b. Find the needed information: N1 + N2 = 397; N2 = N1 + 1

c. Choose a plan:
First equation: N1 + N2 = 397
Second equation: N2 = N1 + 1
Substitution: N1 + (N1 + 1) = 397;

d. Solve the problem: 2N1 + 1 = 397; N1 = 396/2 = 198; N2 = N1 + 1 = 198 + 1 = 199

e. Check the answer: N1 + N2 = 198 + 199 = 397

- The total weight of two boys is 250 pounds. One boy weighs 20 pounds more than the other. Find how much each boy weighs.

a. Understand the question: the unknowns are the two weights of the boys. Students can make a mental or actual picture of the two boys.

b. Find the needed information: W1 + W2 = 250; W2 = W1 + 20

c. Choose a plan:
First equation: W1 + W2 = 250
Second equation: W2 = W1 + 20
Substitution: W1 + (W1 + 20) = 2W1 + 20 = 250

d. Solve the problem: W1 = (250 - 20)/2 = 230/2 = 115; W2 = 115 + 20 = 135

e. Check the answer: W1 + W2 = 115 + 135 = 250

2. Have students work in pairs taking turns reading the questions to each other. Have students describe step by step how they would solve the problem. Then have them work together to write a summary of the steps.

Evaluation

Students work together to check the answers.

Follow-up

1. Ask students to indicate what makes word problems hard. What things help in the solution of word problems? What strategies would the students use again with other word problems?

2. How many word problems can students make up by themselves? Have students write out the problems and write the solutions on a separate piece of paper. Then have students trade problems and work on each other's problems in pairs. Students discuss the steps taken in the problem solutions, and also evaluate how clearly the problems were written.

Definitions:

Algebraic expression: a combination of variables or numerals and variables in which the variables can be replaced by numerals. For example, in the expressions which follow, X and Y can be replaced by numerals: $X + Y$, $X + 2$, $Y - 3$, $(10 - 2)/Y$.

Evaluate an algebraic expression: actually replacing the variables in algebraic expressions with numerals and solving the problem. For example, if $a = 2$ and $b = 3$, evaluate $(2ab - 3b)/ab$. The answer is 3/6 or 1/2.

Equation: two algebraic expressions that represent the same number or that are equivalent. For example, $(a + b) + c = a + (b + c)$.

Grouping: using parentheses to show operations, as in

$(a + b) + c = a + (b + c)$ the associative property of addition

$(a \times b) \times c = a \times (b \times c)$ the associative property of multiplication

Variable: usually a letter or symbol that stands for one or more numbers. For example, X may stand for the number 5 in the equation $5X = 25$.

Chapter 4

English Language Development Through Social Studies

The major objective of the social studies curriculum is to help students understand themselves and others by learning how people live now, how they have lived in the past, and how society has developed in different regions of the world. An important objective in social studies is the development of an understanding of the need for responsible citizenship and how the students themselves can become responsible citizens.

The emphasis in social studies content is on the history and geography of different peoples and places. Some aspects of political science, economics, sociology, and anthropology are often integrated into the social studies curriculum in the middle and upper grades. The scope and sequence of social studies is similar in most curriculum guides and textbook series. Young children begin by learning about their immediate environment of family, school, and neighborhood. The scope expands in middle grades to include their city, state, and nation, and they begin to learn about life in other parts of the world and in other periods of history. United States history is typically taught at three levels: fifth grade, eighth grade, and eleventh grade. World regions, ancient history, European history, Latin American history, political geography, and government (citizenship) are other content areas generally found in the social studies curriculum.

The traditional approach to teaching social studies has stressed the importance of acquiring basic factual knowledge about historical events and geographical features. Recently, social studies educators have argued that the social studies curriculum should not only teach facts but also seek to develop concepts with universal applications, such as roles, values, institutions, culture, environment, needs versus wants, interdependence, and change. Concept development comes about as the result of active investigation of facts and the use of inquiry or thinking skills (Bacon 1976). This type of instructional approach requires active and thoughtful student participation which can be developed through learning strategies instruction and language development activities.

In addition to concepts, the social studies curriculum is also designed to teach skills which, though specific to the discipline, have wide application for the development of academic competence in LEP students. These include reading, listening, vocabulary development, academic communication, reading maps and graphs, making tables and charts, study skills, and research and report writing skills. All of these skills develop language proficiency directly relevant to school achievement.

Because the social studies curriculum requires a high level of literacy and because the concepts developed often deal with abstract ideas rooted in philosophy, anthropology, political science, and economics, we suggest that this content area be introduced to LEP students after they have had some experience with science and mathematics lessons in the CALLA program.

Social Studies for LEP Students

Since social studies depends so heavily on language, LEP students encounter many difficulties in understanding information presented by the teacher. Even more difficult to understand is the generally decontextualized language in the social studies textbook. In addition to understanding the language used to discuss social studies topics, students must also be able to discuss the concepts being developed, and acquire competence in the skills taught. Some typical difficulties encountered by LEP students in a mainstream social studies class are the following:

Vocabulary. As in other disciplines, a specialized vocabulary exists for social studies which students need to learn in order to discuss and report on the ideas presented. As an example of the vocabulary required for just one area of social studies, the state of Maryland lists 94 technical terms which students are expected to learn as preparation for a competency exam in citizenship required for high school graduation. As students move up through the grades, the social studies vocabulary becomes increasingly difficult because of the complexity of the concepts it represents. Words like democracy and representation, for example, are more than simple vocabulary items because they stand for a complex set of ideas developed from a philosophy of government which may be unfamiliar to a LEP student. The following paragraph from a study guide for high school students, while written fairly simply from a grammatical point of view, illustrates the vocabulary complexity with which students must deal (Maryland State Department of Education 1985, 115):

> Federalism means the division of governmental powers between the national and state governments. Both levels of government may act directly on citizens through their own officials and laws. Both levels of government derive their power to act from our Constitution. Each level of government has certain subjects over which its powers are supreme. Both levels of government must agree to changes in the Constitution.

Discourse. Expository discourse is used to present facts and concepts in social studies. The usual pattern is to begin with a series of chronological events, as in history, or clusters of related facts, as in geography. This initial presentation is frequently followed by or is integrated with a discussion of the causes, effects, and evolution of the events or facts described. Students are encouraged to make inferences about meanings, relationships, and unifying concepts. This type of discourse is substantially different both in organization and in content from the narrative discourse found in ESL textbooks and readers which may constitute a LEP student's total previous experience with extended text in English.

Structures. In social studies textbooks, long sentences with multiple embeddings are found even at the elementary level, and increase at upper grade levels. Cause and effect statements are frequent, and a common stylistic variant is to begin sentences with the *because* phrase. While this may be chronologically logical, it is grammatically difficult because LEP students may be accustomed to finding the subject of a sentence close to its beginning, rather than in its second clause. The following example from a third-grade textbook illustrates this point:

> Because there will be more people in the world in the future, we will need more land on which to build towns and cities (Buggey 1983, 233).

Social studies texts also use various tense forms and markings in historical narrative to describe temporal relationships to the period being studied. An example from a sixth-grade textbook (with verb and verb phrase underlining added) is as follows:

> "I *found* Rome a city of bricks and *left* it a city of marble." Augustus *is supposed to have spoken* these words as he *lay dying*. He *was* Rome's first emperor, and *started* the first of its great building programs. He *claimed* that he *had had* over 80 temples *rebuilt* (Marvin, Marvin, and Cappelluti 1976, 154).

In this passage, the verb forms used clarify the sequence of past events, but the variety of forms and use of complex structures such as *is supposed to have spopken* and *had had* could make comprehension difficult for a LEP student.

Another structural feature used frequently in social studies textbooks is *it* as a referent to a previously cited event, fact, or conclusion. When a sentence starts with *it*, the less proficient English reader may have difficulty in identifying what *it* refers to without going back to the previous sentence (or even paragraph).

Language skills. Academic language skills are utilized in social studies as in other content areas of the curriculum. Emphasis on particular skills may vary with the grade level and the teacher, but in general students must be able to learn primarily through listening and reading, and to express understanding of the facts and concepts presented through participation in class discussions and through writing answers to questions and reports on research. Table 4 describes the use of the four language skills in the social studies classroom at different grade levels. As this table demonstrates, some classroom language activities such as understanding explanations, answering questions, and asking for clarification are important at all grade levels. The more cognitively demanding tasks of the higher grade levels require a high degree of literacy, because in these grades students must be able to read to learn and to write to express learning. This table can be used by the teacher preparing CALLA lessons to identify the types of language activities that should be included.

Study skills. Social studies skills include and build on study skills developed in ESL and/or language arts. Study skills specific to content areas have been identified as: book skills, library location skills, library resources, notetaking and outlining, test taking, varying reading rate, and using graphs, tables, charts, and maps to find and relate information and to make comparisons and projections (Askov and Kamm 1982).

ESL teachers can prepare students for eventual mainstreaming in this content area by incorporating language activities with social studies topics appropriate to their students' age and grade level. Teachers can also provide valuable assistance to their students by showing them how to use learning strategies to help understand and remember the material presented.

Table 4

Language Skills Required By Social Studies

Skill	Grades 1-3	Grades 4-6	Grades 7-1
Listening			
1. Understanding explanations.	●	●	●
2. Listening for specific information.	0	◐	●
Reading			
1. Understanding specialized vocabulary.	0	◐	●
2. Understanding information in textbook.	0	◐	●
3. Finding information from graphs, charts, and maps.	0	◐	●
4. Using a flexible reading rate (skimming and scanning).	0	◐	●
5. Finding information in reference materials.	0	◐	●
Speaking			
1. Answering questions.	●	●	●
2. Asking for clarification.	●	●	●
3. Participating in discussions.	●	◐	◐
4. Presenting oral reports.	0	◐	●
Writing			
1. Writing answers to questions.	0	●	0
2. Labeling maps, graphs, and charts.	●	◐	0
3. Writing reports.	0	◐	●

less emphasis → more emphasis

0 ◐ ●

Mainstream teachers can help LEP students overcome some of the language difficulties presented by the social studies curriculum by providing additional language practice with the material, and where necessary, simplifying the language (but not the content) of the material presented.

Both ESL and mainstream teachers should include activities in social studies lessons that are relevant to the culture and ethnolinguistic background of their students and that utilize an inquiry approach to develop students' thinking skills and learning strategies.

The inclusion of multicultural activities and education in global issues at all grade levels is increasingly recommended as an important component in the social studies curriculum (Grambs 1981; Johnson and Benegar 1983). LEP students bring rich resources of personal experience, knowledge, and understanding to the social studies class. They can provide a great deal of cultural information to supplement that provided by textbooks and other materials.

Haggard (1985) proposes an interactive strategies approach to reading in content areas such as social studies. In this approach, students use metacognitive, cognitive, and social-affective strategies as they read to learn. The first step is for students to work cooperatively in small groups to actively recall what they already know about the topic to be studied. They then predict the types of information that will be found in the reading selection, and read to confirm or adjust their predictions. Next, students organize the information they have read through a variety of activities which require identification of major concepts and understanding of relationships. An example of this type of organizing activity is one in which students make individual maps on which ideas remembered from the reading are written and lines and arrows drawn to indicate the relationships perceived between these ideas. This also serves as a self-evaluation activity, as students find out for themselves how much they learned from reading. Another activity suggested by Haggard which requires the use of learning strategies is a vocabulary activity in which students individually select the vocabulary words they consider essential to the reading, then develop group lists and definitions cooperatively. Haggard found that when students develop their own lists of essential vocabulary to remember in this way, they not only retain the meanings, but also tend to produce lists quite similar to what the teacher might have produced.

We have described some of the types of activities which can be developed by the ESL or mainstream teacher to teach social studies content, academic language skills, and learning strategies. The next section provides specific guidelines for teaching lessons and includes samples at the end of this chapter.

Teaching Guidelines

The procedures suggested for planning a CALLA lesson in chapter 1 should be followed for developing social studies lessons. First, teachers should identify social studies objectives. These content objectives should be appropriate for the age and grade level of the students, and should seek to develop both subject-matter concepts and social studies skills including how to use maps, graphs, and reference materials. In order to avoid a watered-down curriculum, topics should be selected from the mainstream curriculum at the students' grade level, rather than choosing topics from lower grade levels which may not be sufficiently interesting or challenging for students. The ESL teacher can benefit from the advice of the mainstream classroom teacher on establishing content objectives and choosing topics for lessons.

Language objectives should be identified. While the mainstream curriculum and instructional materials may present a lesson that utilizes only one language skill, such as reading comprehension, the CALLA model incorporates a variety of language activities to enhance the academic language development of LEP students. These activities may include vocabulary development, listening comprehension, academic discussion, report writing, oral presentation, practice in using difficult grammatical structures, and reading for different purposes.

Teachers should determine the learning strategies that students can use to understand, retain, recall, and use both the content information and the language skills presented. Learning strategies can be selected from those described in chapter 1. Teachers may want to add to these other learning strategies they have found effective, and they may also ask students who are using learning strategies on their own to share their special techniques with their classmates. In the next section we identify learning strategies that are useful for the vocabulary, reading, listening, discussion, and writing activities that take place in social studies classes.

As with other CALLA lessons, teachers should plan to evaluate social studies language skills and social studies concepts separately to the degree possible. This is particularly difficult in this content area because so much of social studies learning takes place through context-reduced language activities, which is why social studies is introduced after science and mathematics in the CALLA model. A useful rule to follow in developing assessment activities for social studies is to keep the language extremely simple when testing for content and to keep the content extremely simple when testing for language. The area of social studies also may present evaluation difficulties that can be attributed to culture. Cultural assumptions underlie social studies content to a much greater degree than they do for science or mathematics, and this can increase the possibility that questions on social studies tests may contain unfamiliar cultural referents.

Learning Strategies

Learning strategies for social studies vocabulary, such as geographical regions or a country's products, can include grouping, in which students classify new words according to functions or semantic categories; and imagery, in which they make a mental picture of the word or concept to be remembered. Cooperation is a useful strategy for vocabulary learning because students can work together to analyze the meanings of new words, look up definitions in dictionaries, quiz each other, or work together on crossword puzzles.

Learning strategies for reading a social studies text can include advance organization in which students skim through a chapter or unit before reading it in order to preview the topic. For example, the chapter on life in mountain regions in an upper elementary textbook on world geography (Bacon 1976) includes photographs with captions, section headings, maps, graphs, and discussion questions which students can look at prior to reading in order to get an overview of the concepts to be presented. Students can then practice selective attention as they scan a text for specific information and identify main ideas, such as people and dates in a history text or geographical features and resources in a geography text. Inferencing is used to guess at the meanings of new words through context clues, and is also used for predicting a conclusion or result. Notetaking and summarizing are two strategies that can assist in the recall of material read. In addition, transfer and elaboration are strategies which can assist social studies reading. Examples of the use of these two strategies are provided in chapter 1.

Learning strategies to assist students in listening to a teacher's explanation of a social studies topic, such as the Lewis and Clark expedition or the functions and powers of the three branches of the U.S. government, can include selective attention, in which they listen for the most important facts, such as causes of an event, important dates, names, and products. In addition, students use selective attention when they attend to the language markers that give clues to the type of information the teacher is about to present.

Two other important strategies that can assist listening comprehension are probably quite familiar to teachers as the study skills notetaking and summarizing. A notetaking system that is easy to use is called the T-List (Hamp-Lyons 1983; O'Malley et al. 1985b). Use of the T-List system for listening to a social studies minilecture on a history topic is described in the social studies sample lesson 2. Summarizing differs from notetaking because the student must select and reformulate the major ideas presented, rather than merely identifying both main ideas and details as in notetaking. In addition, a summary can be oral or written.

Another learning strategy that can assist listening recall is cooperation. After listening to an explanation, students can consult each other to reconstruct as much of the information as possible by pooling what each recalls.

Learning strategies for speaking and listening interactions in the social studies class are the same as for other content areas. That is, students can use selective attention to the teacher's questions in order to aid comprehension, and can practice questioning for clarification in order to check how well they have understood.

Learning strategies that are useful for preparing and presenting oral reports on social studies topics, such as the one described in sample lesson 1, can begin with organizational planning. In this strategy, students plan the organization of the presentation or report and then check to identify the language that will be needed. After this initial planning stage, students can begin preparing their report through the use of additional strategies such as resourcing and cooperation.

Learning strategies that can be used for writing social studies reports are the same as those used for developing oral reports. A high school student writing a research report on the causes of the decline of the Roman Empire, for example, should begin by using the strategy of organizational planning. The student might decide that the form of the report should include an introduction, a main body containing a description of important events and their causes, and a conclusion which summarizes the importance or result of the decline of Rome as a power. In addition, the student should plan to incorporate linguistic markers which signal the different sections and which distinguish main ideas, details, and the sequence of events.

Once the initial organizational planning for the report is done, the student will need to use the strategy of resourcing, which encompasses a variety of study skills, including the use of reference books and the library. LEP students may need instruction in some beginning level resourcing strategies if their previous education has not included this type of activity. Practice in using reference books in the classroom can prepare students for the more difficult task of finding needed information in the school or public library.

Finally, in writing the report on the decline of Rome, the student will find that the use of the learning strategies of cooperation and self-evaluation is helpful. In cooperation, students work with their classmates to share and ask for feedback to their reports. In self-evaluation, students look critically at their draft reports and decide what changes need to be made for the final report. These types of activities are an important feature of the process approach to writing, which is particularly effective in improving LEP students' written compositions (Hudelson 1984; Trueba and Moll 1984).

Many of these learning strategies are applied in the sample social studies lessons that conclude this chapter. In planning similar lessons, teachers need to remember that the social studies curriculum has many language-dependent activities which may pose difficulties for LEP students. The CALLA model for content-based English language development includes both content and language objectives for each social studies lesson. Learning strategies can help students understand and remember both the concepts and language skills related to the social studies curriculum.

Social Studies Sample Lesson 1

Developing a Social Studies Report

Language Objectives:	Vocabulary and oral language development, reading comprehension, report writing, oral presentation, listening comprehension, taking notes on a presentation
Social Studies Objectives:	Learn about three Spanish explorers: Cabeza de Vaca, Ponce de Leon, de Soto; practice using information on timelines to develop a report; use map skills to identify areas explored by the three explorers
Learning Strategies:	Metacognitive--selective attention, organizational planning, advance preparation, self-evaluation. Cognitive--transfer, imagery, inferencing, resourcing, notetaking, summarizing. Social/affective--cooperation, questioning for clarification
Grade Level:	Upper elementary, junior high
Materials:	Model social studies report, two history fact sheets with events arranged on a timeline, report form

Procedures:

Preparation

1. Conduct a brainstorming session in which students tell all they already know about explorers for Spain, and write the information on the board. (Hispanic students who have had schooling in their native countries can be used as information resources.) Identify new vocabulary words related to exploration and go over them with students.

Presentation and Practice

1. Provide students with a short report (see the report on Cabeza de Vaca for an example) that is divided into an introduction (tells what the report is about), a body (tells the most important points and gives one or two details for each), and a conclusion (tells what the report was about and why that explorer was important).

2. Have students read the model report silently, then have them identify the following markers:

   Words that tell what the report is about;
   Words that indicate a main idea;
   Words that indicate an example or detail;
   Words that introduce the concluding paragraph.

3. Provide students with fact sheets about two other Spanish explorers, arranged on a timeline (see examples for Ponce de Leon and de Soto). Remind students that timelines help them understand a sequence of events that happened in history.

4. Have students sit in pairs to go over the information on the fact sheets. Provide students with outline maps to use to help them visualize the routes of Ponce de Leon and de Soto, and then draw the routes on the maps. Each pair of students should decide where and how they will draw the routes, and how they will distinguish between them.

5. Still working in pairs, students decide which explorer each will report on.

6. Provide students with a report form which is divided into three sections-introduction, body, and conclusion-and which supplies some of the linguistic markers for each section (see example). Students write their first drafts (in pencil) on these forms.

Evaluation

1. Have students go over their reports carefully and rewrite or make corrections as appropriate. They may do this in pairs, working with a partner who is writing about the same explorer.

2. As a home assignment, have students practice reading their reports aloud five times or more. It is helpful to use a tape recorder so that each student can play back his/her report and evaluate it. Examples of self-evaluation questions for students to answer are: Do I speak too fast, too slow, or about right? Is my voice too loud, too soft, or about right? Can others understand my pronunciation?

Practice and Evaluation

1. Provide time for students to practice their reports while showing the route of their explorer on the map. This can be done in small groups, in which case, all members of the group should be reporting on the same explorer.

2. Have students sit in pairs with their original partner and take turns presenting their reports to each other. While one student is presenting, the other should be taking notes on the presentation. After each presentation, the person taking notes may ask questions for clarification to be sure that all the information taken down is accurate, and then writes a one paragraph summary of the notes. Presentations can be evaluated according to the accuracy of the summaries.

Follow-up

Provide students with U.S. history books, library books on Spanish explorers, and a junior encyclopedia. Have them find out and write down three facts each (name, area explored, dates) about another Spanish explorer, then share this information in small groups.

This lesson is from Language Development Through Content--Social Studies; America: The Early Years. Reading, MA: Addison-Wesley (in press).

Sample Fact Sheets with Timelines

JUAN PONCE DE LEON

1474	Born in Spain.
1493	Sailed with Columbus on his second voyage to America.
	Settled in Hispaniola.
1508	Explored Puerto Rico. Found gold. Conquered Indians and claimed Puerto Rico for Spain. First governor of Puerto Rico.
	Heard stories about Fountain of Youth. "People who drink water of Fountain of Youth stay young forever."
1513	Went in search of Fountain of Youth. Explored east coast and southern tip of Florida. (First European expedition to Florida.) Claimed land for Spain but didn't find Fountain of Youth.
1521	Second voyage to look for Fountain of Youth. Landed on west coast of Florida. Tried to start a colony. Indians attacked; Ponce de Leon killed.

HERNANDO DE SOTO

1500	Born in Spain.
1533	Went to Peru to help Spanish army conquer the Incas. Convinced Inca ruler to meet with Spanish commander. Then Spanish soldiers captured Inca ruler.
1538	Became governor of Cuba.
1539	Decided to explore Florida, "a land of gold." Landed on west coast of Florida. Didn't find gold.
	Traveled throughout southeast section of North America looking for gold. Didn't find gold, but claimed all land for Spain.
1541	Crossed Mississippi River (first European who did). Explored what are now Arkansas and Louisiana. Didn't find any gold.
1542	Returned to Mississippi River. Died of fever. Buried in Mississippi River.

Examples for Social Studies Report

(These examples are from Addison-Wesley's Language Through Content: American History, 1986 publication.)

Sample Model Report

A. Introduction

A. This report is about Alvar Nunez Cabeza de Vaca. He was a Spanish explorer. He was born about 1490, and he died about 1557. He explored parts of what are now the states of Florida and Texas. He claimed these areas for Spain.

B. Body

B. The first important point about Cabeza de Vaca is that he went from Mexico to Florida in 1528 to look for gold. A black slave, Estevan, was also on this expedition. The expedition got lost, and many men died. They did not find any gold, either. When Cabeza de Vaca finally got back to the coast where he had left his ships, they were gone!

The second important point is that Cabeza de Vaca and his men built small boats and tried to sail back to Mexico. A terrible storm sank most of the boats. A few boats landed on a small island near the coast of Texas. Cabeza de Vaca and Estevan were in one of these boats.

The third important point is that a group of Indians took Cabeza de Vaca and his men prisoners. While they were prisoners, Cabeza de Vaca and Estevan heard the Indians tell stories about seven cities of gold.

The fourth important point is that Cabeza de Vaca and his men were finally freed. They returned to Mexico City in 1536, eight years after they had left. They told about the cities of gold. The Spanish government sent more explorers to find these cities of gold.

C. Conclusion

C. In conclusion, this report has been about the Spanish explorer Cabeza de Vaca. He was important because he was one of the first explorers in Florida and Texas. Although he didn't find any gold, he did claim these areas for Spain. He also convinced the Spanish government that more explorers should be sent to look for gold.

Writing a Report

TITLE OF REPORT ____

A. This report is about ______________________________.

He was a __________ explorer. He was born in __________ and he

died in __________. He explored ____________________________

____

and he claimed these areas for ____________________.

A. Introduct

B. The first important point about ___________________________

____

____

The second important ____

____

____

____

The third ____

____

____

____

The fourth ____

____

____

B. Body of R
Tells th
adventur
the expl
and give
and some
details.

C. In conclusion, this report has been about __________________

____

He was important because _____________________________________

____

____

C. Conclusi

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Social Studies Lesson 2

Listening and Taking Notes in Social Studies

Language Objective:	Listening comprehension, oral language development, notetaking
Social Studies Objective:	Find out about relationship between Pilgrims and American Indians
Learning Strategies:	Metacognitive--selective attention, self-evaluation. Cognitive--transfer, inferencing, notetaking, summarizing, resourcing. Social/affective--cooperation, questions for clarification
Grade Level:	Junior and senior high
Materials:	Text for a short lecture or explanation (can be on tape); T-List form with notes partially filled in

PROCEDURES:

Preparation

1. Have students contribute information they already know about American Indians and their relations with European settlers. Write contributions on the board, highlighting new vocabulary as it occurs.

2. Explain to students that they are going to hear a short lecture on an American Indian named Massasoit. They will listen, take notes, compare their notes with classmates, and then write short summaries of the lecture. The lecture they will hear will be organized into three parts: introduction, body, and conclusion.

Presentation

1. Write the language markers that students will hear in the lecture on the board, and explain that each signals the type of information to follow. For instance, if they hear the word important, it means that a main idea is to be presented. When they hear sequence words like first, second, it indicates the beginning of a new sequence or episode. Other markers indicate the topic ("I'm going to talk about..."), the summary statement ("In conclusion..."), or details ("for example...").

2. Explain the T-List procedure to students. In this system of notetaking, they will write main ideas on the left and the corresponding details on the right, as shown in the sample T-List form for Massasoit.

3. Show students how to jot down phrases and make abbreviations when taking notes. Write a complete paragraph on the board, then ask students to tell you which words are not necessary for comprehension,

such as and, the, very. Erase those words and abbreviate as many of the remaining words as possible. Have students practice reconstructing the original paragraph by referring to the notes on the board.

Practice

1. Read another sample paragraph to students and have them take notes as instructed above.

2. Check comprehension of the paragraph students have just taken notes on, and ask them for meanings of any new words. Ask them how they figured out the meanings or approximate meanings of these words. Remind them that they can use what they already know about a topic as well as the words surrounding the new words to assist comprehension.

3. Read a third paragraph and have students tell what they already know about the topic and practice inferring meaning of new words.

4. Read or play a tape of a short lecture organized on the model of the Massasoit lecture below. Students take notes using a T-List. While learning this procedure, the T-List form should have some information already on it, so students fill in missing information as a cloze exercise (see model below). With practice, these cues should be diminished so that eventually students can take notes without this assistance.

Evaluation

1. Have students sit in small groups to compare their notes, discuss the lecture, pool information, and fill in any missing information on their T-Lists.

2. Have students answer self-evaluation questions, either orally or in writing. Sample questions are: What parts of the lecture were easy to understand? What was difficult? Was it difficult because of the ideas or because of the language--or both? What did I do to try to understand and remember the information presented? How good a listener and notetaker am I?

Follow-up

1. Have students write brief summaries based on their notes, then work in pairs to revise and edit them.

2. Provide students with additional sources of information about relations between American Indians and European settlers. Have them apply the T-List procedure to reading for information. This additional information can then be summarized and shared with the class.

This lesson is from Language Development Through Content--Social Studies; America: The Early Years. Reading, MA: Addison-Wesley (in press).

Listening Text for Massasoit

Today you are going to hear about an important American Indian. His name was Massasoit. He believed in peace, and he was friendly to the Pilgrims who settled in Plymouth.

First you will hear who Massasoit was and what he did. Massasoit was the chief of the Wampanoag tribe. He ruled the area that is today Cape Cod part of Rhode Island. When the English Pilgrims arrived in America in 1620, Massasoit did not fight them. Instead, he signed a peace treaty with the new colonists in 1621.

Now you will hear how about the first Thanksgiving. The Pilgrims were very glad that the Indians were friendly and helpful. For instance, when they were hungry, Massasoit sold food to them. When the Pilgrims celebrated their Thanksgiving, they invited Massasoit and members of his tribe to the feast. The Indians came, and brought food for the feast also. This was probably the first time that Europeans and American Indians learned that they could be friends.

Next you will hear how the Pilgrims and Massasoit helped each other. One example was when Massasoit was very sick, and one of the Pilgrims cured him. Another example was when other Indians planned to attack the Pilgrims and Massasoit warned them.

Finally, let's see what happened after Massasoit died. Although Massasoit believed in peace, there was war after he died. His son Metacomet, who was called "King Philip" by the English, decided to attack the English because he did not want them to take any more Indian lands. The war lasted for two years, and many Indians and English colonists were killed. Massasoit's ideas about peace were forgotten.

In conclusion, Massasoit was important in American history. He signed a peace treaty with the Pilgrims and was a good friend to them for the rest of his life. He was a man who believed that peace was more important than war.

SAMPLE T-LIST

Main Ideas	Details and Examples
Introduction	
Massasoit important American Indian	1. Believed in ________
	2. Friendly to ________
A. Who he was; how helped Pilgrims	3. ________ of Wampanoag ____.
	4. Ruled ________, part of ________
	5. Peace treaty with ________ in ________
B. First Thanksgiving	6. ________ friendly, helpful
	7. Sold ________ to colonists
	8. Pilgrims invited ________ to ________
	9. Europeans and American Indians ________
C. Massasoit and Pilgrims helped each other	10. Pilgrims helped Mass. when ________
	11. Mass. ________ Pilgrims about
D. Massasoit's death - problems	12. Son Metacomet (______ Philip) attacked ________
	13. War for ______ years
	14. Many ______, both sides
Conclusion	
Importance of Massasoit	15. Signed ____ treaty with ____
	16. Believed in ______.

Sample Social Studies Lesson 3

Writing Your Family's Story

Language Objectives: Vocabulary development, oral language development, notetaking, narrative composition, listening comprehension

Social Studies Objective: Develop understanding of immigration to the U.S. and own family's contribution to it, practice map skills

Learning Strategies: Metacognitive--advance organization, organizational planning, self-evaluation. Cognitive--transfer, imagery, notetaking, resourcing, summarizing. Social-affective--cooperation, questions for clarification

Grade Level: Upper elementary

Materials: A family tree form with spaces for three generations

Procedures:

Preparation

1. Discuss the reason why the United States is called a nation of immigrants. Ask students to share information about how their own family immigrated to the U.S.

2. Have students make family trees showing where they were born and where their parents and grandparents were born (see sample below).

Presentation and Practice

1. Review note-taking techniques (see lesson "Listening and Taking Notes"). Have students take notes on their own family's immigration history. They should take notes on where there family lived before coming to the U.S., how they lived in their previous country, why they left that country, how they came to the U.S., what happened when they arrived here, and problems they have had in the U.S. and how they have solved them. Encourage students to interview family members in order to gain as much information as possible.

2. Have students organize and plan their compositions by deciding on the structure (such as an introduction, a body, and a conclusion--see lesson "Developing a Social Studies Report"), and the sequence of ideas to be presented. Then they should identify vocabulary, possible language markers, and any other language information that will be needed in the composition.

3. Students should ask the teacher or other native English speaker to provide new words and expressions needed.

4. Students write the first draft of their compositions. They should focus on expressing their meaning rather than on correctness at this point, as they will have opportunities to edit for spelling and grammar later.

Evaluation

1. Students work in pairs with a friend to exchange compositions and critique them. The writer should have a short list of questions to ask the reader for self-evaluation purposes. Sample questions might be: "Do you understand the story? Are the ideas in the right order? Which parts could be improved? Are there any errors?"

2. Students revise their compositions one or more times, incorporating their classmate's suggestions, if appropriate, and their own new ideas and/or corrections.

Practice

1. Students sit in small groups and read their compositions to each other. Students take notes as they listen to each others' compositions and then share the notes with the author.

Evaluation

1. Students use their classmates' notes to evaluate the degree to which they have been able to communicate effectively.

Follow-up

1. Provide elementary textbooks and easy library books that deal with immigration. Have students work in groups to find out more information about an immigrant group of their choice. They should write brief summaries of the information as a group project, and then share the summaries with the rest of the class.

2. Have students keep journals of their families' experiences as immigrants.

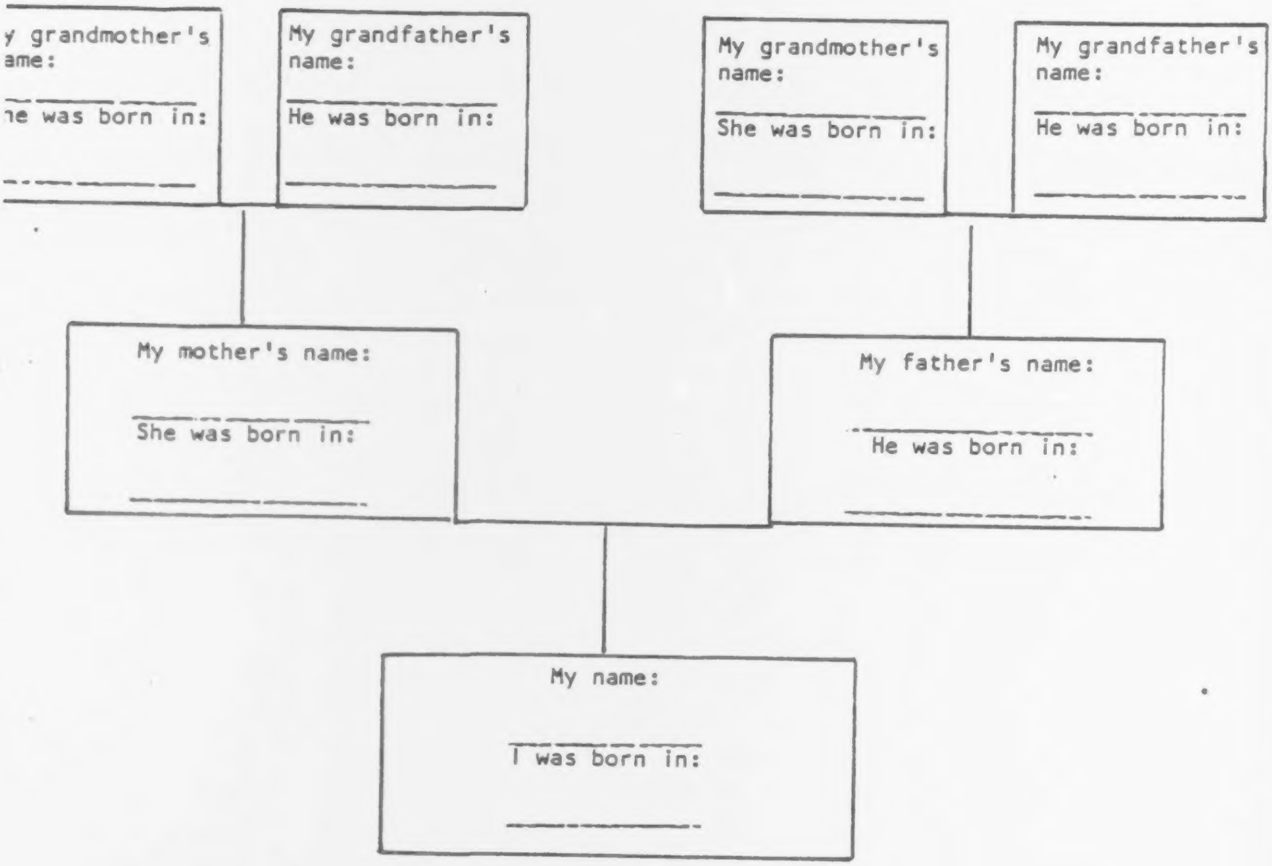
This lesson is from Language Development Through Content--Social Studies, America: After Independence. Reading, MA: Addison-Wesley (in press).

Sample Family Tree

Your Family Story

Except for American Indians, everyone's family in the United States were immigrants once. Some families were immigrants many years ago. Other families were immigrants a short time ago. What about your family? Complete the family tree below. Write in the names of your family members and the country where each person was born. Ask your parents or another family member to help you.

MY FAMILY TREE



y grandmother's
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he was born in:
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My grandfather's
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He was born in:
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My grandmother's
name:
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She was born in:
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My grandfather's
name:
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He was born in:
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My mother's name:
____
She was born in:
____

My father's name:
____
He was born in:
____

My name:
____
I was born in:
____

Now you will write a story about how your family came to the United States. (You can write a story about another family if you prefer.) First you will make notes on the important things in your family's immigration story. Second, you will write the story on a separate piece of paper. Third, you will work with a friend to make your story better. Fourth, you will write your revised story. Finally, you will read your story to a group of classmates and listen to their family stories.

Chapter 5

Assessment and Evaluation

This final section of the teacher's guide to a Cognitive Academic Language Learning Approach (CALLA) addresses the assessment of academic achievement and English language proficiency. The focus is on assessment of academic language and content knowledge to determine the student's readiness for mainstreaming. The purpose of this section is to encourage teachers to differentiate between academic achievement and language proficiency in their classroom testing and to prepare students for the multitude of testing situations where no such distinction has been made. Teachers can play an important role in guaranteeing that students are tested for content-area achievement with reduced language demands before the students are exposed to tests in which knowledge of content and language are confounded and therefore test scores are impossible to interpret.

One of the reasons for the failure of LEP students in mainstream classes is that initial English-language instruction does not prepare these students for academic content to receive instruction. Whether in a bilingual classroom or in ESL, the instruction has probably not included academic language in English that is a part of mathematics, social studies, or science. Consequently, the students may be unfamiliar with the specialized language that is unique to each of these areas, and will have little practice in using English as a medium of thought with the subject matter. The students may have difficulty later in mastering the content area more because of the language demands than the difficulty of the content. CALLA combines content-area instruction with instruction in English language development to overcome this difficulty and uses student-initiated strategies for learning and retaining important concepts during CALLA instruction that are applicable in mainstream classrooms.

In this section we discuss how the CALLA teacher can assess the content area knowledge of students before they exit to mainstream classrooms. This assessment will enable the teacher using CALLA to determine the extent to which students have acquired academic language proficiency in specific content areas. We also discuss procedures by which the teacher can prepare students for testing situations in which the language demands of the test can be expected to produce problems for the students. As background for this section, we reintroduce the concept of academic language proficiency and indicate the reasons why instruments presently available to assess English language proficiency and content-area achievement are not appropriate for assessing academic language skills of LEP students. We then provide specific recommendations for approaches that teachers can use in assessing content area knowledge with reduced demands on English language proficiency and other strategies that teachers can use to prepare students for standardized tests of content-area knowledge.

Definition of Academic Language

Language proficiency has been described in terms of two continua ranging from cognitively demanding to cognitively undemanding, and from context embedded to context reduced (Cummins 1980). This distinction was cited initially in chapter 1, and was depicted in figure 2. Briefly, cognitively demanding tasks are those typical used in content areas where

English is not only a vehicle for comprehension and expression but also for thinking and reasoning. The cognitively demanding continuum refers to the degree of active conceptual involvement required to perform the task, that is, to the amount of conceptual processing necessary to complete the task. Context embedded tasks may involve demonstrations and objects with rich cues for meaning, while context-reduced tasks involve abstractions without concrete referents.

Academic language is language that is involved in most academic tasks and is typically distinguished from that used in face-to-face communication (Cummins 1980 1981). Academic language is often both context reduced and cognitively demanding. One example of academic language is a teacher talking to a group of 30 students on an abstract concept like justice, where the cues for meaning are substantially reduced compared to the cues evident in a face-to-face encounter. A second example is provided by texts in most content areas, where extralinguistic cues such as the nature of the setting and gestures of the speaker are not available. The principal cues for meaning with content-area texts lie in redundancy or in supportive information provided to complement the principal narrative, such as illustrations and diagrams. As we have pointed out earlier, even the cues for redundancy found in most other academic language are reduced with mathematics. In sum, understanding and using academic language requires a different type of knowledge of the language than is typically required in non-academic situations and relies heavily on literacy skills.

Most instruments that are designed to assess English language proficiency do not assess academic language skills. These instruments are typically designed for identification of LEP students upon entry to a bilingual or ESL program. The instruments may assess vocabulary, grammar, and reading, and listening skills, but are not designed to assess language skills at the level required for adequate performance in a mainstream classroom. The tests fail to assess content-area knowledge altogether. Consequently, they do not assess the type of language a student needs to know upon exit from one of the special programs designed for LEP students (Cervantes 1982; Solkov-Brecher 1984).

Current Approaches to Assessing Academic Language Skills

Most standardized achievement instruments that assess content mastery assume native proficiency in English in addition to knowledge of the content area. Students who obtain high scores have demonstrated understanding both of the English language in an academic context and knowledge of the content area. Scores at the lower end of the distribution are difficult to interpret for a variety of reasons.

- The student may be unable to use English as a medium of thought,
- The student may require extra response time due to conceptual processing requirements in English;
- The student may be unable to understand the content-area vocabulary or syntax;
- The student may not have knowledge of the content area required to obtain correct responses.

Thus, assessment of academic language and content-area knowledge are irretrievably confounded in most achievement tests. Because academic language skills of LEP students cannot be assessed using either English language proficiency tests or tests of content-area knowledge, teachers who are interested in gaining a profile of the content-area knowledge of their students in classrooms must prepare their students to take standardized tests and must also design their own instruments.

Guidelines for Teachers of LEP Students

Teachers who understand that standardized achievement tests typically confound the assessment of academic language and academic content can do three important things: teach students the language of testing, teach students the cognitive skills required in standardized testing, and learn how to design their own content-area tests, containing reduced demands on English language proficiency.

Teaching test taking skills. The first step in reducing the language requirements of content tests is for teachers to familiarize their students with the language of testing. Almost all tests have in common a special type of language that students will rarely encounter in other settings. Examples of this type of language are as follows:

- Choose the one answer that . . .
- Match the items in column A with the items in column B
- Fill in the answer that . . .
- Write a paragraph that explains . . .

The teacher can provide experiences to students in which they are called upon to respond to language of this kind using varied types of items with content that is relatively undemanding. By keeping the content undemanding, the teacher can teach the language first and later introduce appropriate content. The special test language that teachers identify may depend upon the standardized tests used in their local area. The teacher should obtain a copy of these tests and extract samples of the testing language for class exercises. Students thus can gain experience with the language of testing and feel confident that the language will not act as an obstacle to their successful performance.

Teaching cognitive skills. A second activity teachers can do to help LEP students gain competency in the language embedded in achievement tests is to identify the types of cognitive skills that are typically evoked by the achievement test. The manuals for most achievement tests identify the types of cognitive skills that are required in completing the test items. Students taking a content area test may be required to infer vocabulary meaning, understand important concepts, remember information presented in a written narrative, identify key ideas, draw implications, predict a narrative's completion or the next step in a sequence, synthesize information from different sources, or solve word problems.

Teachers can take advantage of information from a test manual on cognitive skills in designing instruction. A teacher who is familiar with and uses knowledge of the content of standardized tests is simply developing a realistic appraisal of the skills the district considers minimally acceptable for successful academic performance. We are suggesting that the teacher also look at the cognitive skill requirements in these tests. Having obtained samples of the standardized tests used in their school district, the teacher can extract some typical items from the content areas. Then the teacher can develop items for classroom use that call upon these same reasoning skills. Quite obviously, the teacher will be interested in giving students instruction in these skills if in fact the skills are being assessed in the district's standardized instruments. The types of concepts included on the test can be made a part of English language instruction just as the language of the test is made part of English language instruction. That is, the teacher can teach the cognitive skills used in the test, without giving away the content of the items on the test. This activity will help teachers ensure that they are giving adequate representation to conceptual skills across the full range of skills assessed in standardized tests used by their district.

Assessing academic achievement in content areas. A third activity teachers may be interested in is to assess student achievement in the content area with reduced demands on English language proficiency. Academic achievement in the content areas must be assessed with reduced English language requirements if the student is still gaining command over academic language skills. To assess content independent of the student's English language proficiency, the teacher will design tests of classroom content that contain reduced demands on English language skills while retaining the full range of academic content presented during instruction.

The teacher can design classroom tests that will accurately assess content knowledge with reduced demands on English by using a number of techniques. We assume that most teachers either have developed their own classroom tests or are using the original or adaptations of classroom tests provided by a text publisher. The teacher will therefore be able to make modifications in the instruments that are used to assess classroom learning. Our discussion of the range of modifications teachers can make in classroom tests is based on the perspective that misunderstandings in reading (as in reading a test item) can come from at least five sources (Lebauer 1985):

- Lexical sources. Unknown definitions, misinterpreted figurative usage, unknown cliches and proverbs, problems with connotations and semantic value;
- Syntactic sources. Unknown grammar, unknown value of syntactic forms;
- Nonlinguistic sources. Failure to recognize conventions of text, such as using italics for emphasis;
- Rhetorical sources. Failure to recognize transitional phrases or rhetorical cues, different discourse expectations; and

- Cultural sources. Different background knowledge, differences in logical thought patterns.

The most important of these sources of misunderstanding for test item construction are probably the lexical, syntactic, nonlinguistic, and cultural sources.

In dealing with lexical sources of misunderstanding, the teacher can simplify the language used in the test by substituting less difficult words for demanding vocabulary the student may not know. The teacher will not make substitutions for vocabulary words that are required by the content area. These were presumably taught during instruction. Nor will the teacher substitute words that are typically required in test taking, such as "complete the following paragraph..." or "choose the one correct response..." These were also covered in a separate part of instruction dealing with test-taking skills. The kinds of vocabulary for which the teacher will substitute new and easier words are the difficult words that are familiar to native English speakers but not to LEP students. Examples are low frequency words and words with specialized meanings, except where Latin cognates may assist native Spanish speakers.

Teachers can simplify syntactic value of test items without simplifying the content by ensuring that grammatical constructions are uncomplicated by lengthy sentences and embedded clauses. Students can focus more on the content if they are not requested to process long and complicated syntactical structures. Individuals designing tests sometimes rely upon complicated syntax as a substitute for sound assessment of the content area. Students who are not as acquainted with English may miss what otherwise would be an easy item because they become confused by the English language construction. Teachers attempting to focus on content assessment for LEP students should therefore concentrate on eliminating complicated language structures from their test items. Other recommendations are to substitute high frequency synonyms for more difficult words, and to paraphrase the meaning of difficult words or phrases.

Teachers should also remember that native English speakers sometimes communicate emphasis, importance, or equivalance through syntactic structure. The LEP student who reads "It was Jefferson who wrote the Bill of Rights" may understand the meaning of the sentence without understanding the special emphasis placed upon Jefferson as author of the Bill of Rights. Nonnative speakers of English who miss a cue entered into a narrative through syntactic structure may find that the missed emphasis detracts from their further understanding of additional text that makes reference to the implicit cue. The teacher can inform students about more common examples of these syntactic variations that are found during inspection of standardized tests used by the district.

Another aspect of the grammatical constructions that might confuse students is the use of conditionals. The use of "if...then," "could...if," and "would...if" may make sense to the teacher attempting to construct a more difficult item. But this type of construction easily confuses LEP students and may result in missed items even though the student knows the appropriate content response. Here too, teachers can help students anticipate these kinds of constructions and give them practice in thinking through the logic of grammatical constructions with conditionals.

Nonlinguistic sources of meaning can also create difficulties for LEP students attempting to understand test items. The use of italics for emphasis is one example of the use of nonlinguistic sources of meaning, as in "It was Jefferson who wrote the Bill of Rights." Other nonlinguistic indicators of meaning include punctuation signals (!, ?), capitals (STOP), sentence length, and paragraph boundaries.

Cultural differences between native English speakers in the United States and LEP students are potentially one of the major sources of misunderstanding test items. Mohan (1986) cites a number of sources of cultural bias that are drawn from specific items identified on standardized achievement tests used in the U.S. Note that any one of the items that Mohan cites could be a legitimate test item if the student had received specific instruction for the culturally relevant information. They are not legitimate if the intent is to assess general achievement or reading proficiency in general, as was true on the specific tests Mohan identified. The sources of bias and test items Mohan used as examples included the following:

- Patriotic objects: There are red and white stripes and white stars in our flag. Our flag contains one ____ for every state.

  (a) stripe (b) star

- Food: In the story the French regarded potatoes like most Canadians regard _____.

  (a) spinach (b) tomatoes (c) horsemeat (d) butter

- Customs: In this poem, what does April Fool! mean?

  (a) The person who said it was fooling.
  (b) It was not April at all.

- Games: Sam won at marbles because he could _____ straighter than Bill.

  (a) show (b) shoot (c) draw (d) run

- History: Clothes for the colonial family were usually made in ______.

  (a) factories (b) homes (c) luxury (d) China

- Geography: The Yankee peddler traded as far west as the Mississippi and as far south as Louisiana. He operated _____.
  (a) over most of the country.
  (b) as far south as Louisiana.

- Folklore: Pam went to the party with a tall pointed hat, long black cape, and a broom. She was dressed as a _________.

  (a) witch (b) ghost (c) cowgirl (d) pumpkin

- Housing: Bill ran out on his front porch to watch the firetruck. He lives in __________.

  (a) a big apartment (b) a city house (c) a trailer

- Culture-bound metaphors: What does applying soft soap mean in paragraph 6?

  (a) looking clean in public
  (b) flattering people

- Stories familiar to particular cultural groups: The person was holding tight to the handle of an open _________, dangling by one hand like a doll tied to the string of a balloon.

Mohan reviewed a number of commonly used reading comprehension tests and found that they contained between 7 percent and 16 percent culturally biased items, clearly enough to make a substantial difference in a LEP student's score. Mohan considered these to be conservative estimates because he did not include borderline cases in the count, and because he was a member of the host culture in which the tests were developed. While culturally related information is important for students to understand, Mohan makes the point that cultural knowledge should be assessed independently of reading comprehension.

Mohan suggests that the litmus test of cultural bias in test items is based on the answers to the following two questions:

- Does the item test only language knowledge or does it test knowledge of the world too?

- Does the item test (a) knowledge of the world which is available to all cultures, or (b) knowledge of the world which is readily available only to particular cultural groups?

Teachers of LEP students can analyze their own classroom tests to eliminate cultural bias and thereby obtain more accurate estimates of the student's content knowledge or English language skills. Furthermore, teachers can identify sources of cultural knowledge of the type expected on the reading comprehension or content-area tests and include this knowledge as part of their instruction. Teachers may also use standards for identifying culturally biased items as criteria for the selection of standardized tests in their school. All other things equal, a test that contains fewer biased items according to the above standards would be preferable to a test that contains more biased items.

Summary and Conclusions

The Cognitive Academic Language Learning Approach (CALLA) combines English language development, content-based English as a second language (ESL), and learning strategies in a unified approach to assist the transition of LEP students into mainstream instruction. The approach is intended for students in the upper elementary through the high school years and focuses on English language development through cognitively based content area instruction in science, mathematics, and social studies. CALLA is intended as a bridge between bilingual or ESL instruction and mainstream classes to supply the academic language skills students need to success in content areas. CALLA can also help the English domininant, but still limited-English-proficient, bilingual student acquire these types of langauge skills. The approach addresses the need for English language skills development in the four language skill areas of listening, speaking, reading, and writing. CALLA is designed to supply added support for English language development among LEP students and is not a replacement for experience in mainstream classes.

CALLA may be useful for mainstream teachers with LEP students in their classes as well as for language teachers. That is, the approach could be used by ESL and other language teachers who have the opportunity to provide their LEP students with a bridge to mainstream classes, or by mainstream teachers who wish to provide LEP students with supplementary experiences to enhance their academic language development and ultimate success. Most appropriately, the approach could be used by the language teacher in a collaborative effort with the mainstream teacher on behalf of LEP students. We are hopeful that both groups of teachers will see many opportunities in CALLA to assist their students in learning academic language skills in English and that they will work cooperatively to do this.

The necessity for the approach is based on the observation that many LEP students fail to realize the promise of their early successes in learning English by continuing to master English once they advance to content-area instruction. This failure to perform satisfactorily in the mainstream is related to differences in the types of language required for success in bilingual and ESL classes and the language required for success in content-area instruction. Whereas the English language requirements of ESL classes may be heavily contextualized and not cognitively demanding, the language requirements of mainstream classes can be both decontextualized and demanding. In the past, schools have asked LEP students to make a transition directly from classrooms characterized by greater contextualization/lower cognitive demands to classrooms in which English can be depicted as having less contextualization/higher cognitive demands. CALLA is designed specifically to mediate this transition.

Our advocacy of presenting science instruction first prior to mathematics and social studies is related to the idea that LEP students making the transition to mainstream instruction need context-embedded experiences with academic language. The science curriculum we suggest is discovery oriented and provides students with numerous opportunities to be directly involved in trying out scientific procedures, observing the consequences, and using academic language. In the setting provided by scientific experiments, students can interact with other students while describing the procedures, reporting the results, and drawing inferences concerning the conclusions. These experiences can be invaluable for gaining command over academic language skills in English and provide a foundation for the introduction of academic language in mathematics. If presented appropriately with reduced language demands, the teacher should find little need to dilute the concept of science or mathematics. The teacher can increase the demands on English language skills over time and thereby increase academic language proficiency among the students.

Because we believe that all student can profit from using more effective strategies for learning, we have incorporated a learning strategy component in CALLA. This component is derived from research in cognitive psychology which indicates that individuals are more effective at learning if they actively process new information through special ways of thinking described as learning strategies. This research has established a solid base for concluding that native English-speaking students learning subject area content will learn and retain new information more effectively if they are trained to use learning strategies. Our own research with strategies in second language learning has indicated that students will learn English as a second language speaking and listening skills more effectively when strategies are used. By incorporating learning strategies in CALLA, we are building on the prior work in cognitive psychology and our own studies of students learning English as a second language.

While we think of CALLA as a integrated program of instruction, we recognize that some teachers will look to specific chapters for ideas depending on their area of emphasis, local teaching assignments, and immediate needs for instructional ideas. For this reason, we have designed each of the content chapters to be independent of the others and to be useful by themselves. We also understand that language teachers may be concerned about their ability to present instruction in areas such as math and science where they may have had little interest or training. The transitional nature of CALLA suggests that these topics should be taught to familiarize students with the academic language requirements in those areas rather than to provide a comprehensive understanding of the substance. Accordingly, teachers can develop lesson plans for elementary skills in these areas provided that essential academic language and grade appropriate concepts are contained in the lessons and students have an opportunity to use English as a medium of thought. The mainstream content-area teacher is an essential resource to the language teacher in order to provide an overview of the language demands in math and science.

In this book we have attempted to supply the fundamental ideas on which CALLA is based and to give teachers of LEP students enough information to continue the development of their own lessons. We have developed the ideas underlying CALLA, presented suggestions on how to incorporate learning strategies into a content-based English language development curriculum, and provided guidelines for combining English language development with content-area instruction. To make the application of CALLA to a transition curriculum explicit, we have presented a sample of specific lessons in science, mathematics, and social studies.

We hope that teachers will realize the potential for developing instruction modules of their own based on the texts and content objectives in their school district. As teachers work on their own to develop a CALLA instructional approach, we hope that they will let us know how CALLA works for them so that we can incorporate their ideas and suggestions as we continue to develop and refine our model.

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